
EX LIBRIS
G Brown Goode
SIBI
ET AMICIS
AIX 1634
BARBADOES
NEW ENGLAND
NEW JERSEY
VIRGINIA
OHIO
Ffor hym was lefere to have at hese bedis hed
Twenty bokis I-clad in blak or red
Of Aristotle & his philoso-phie
Than robis ryche or fedele, or gay sautrie
S. I.
U.S. National Museum
S. I.
Baldwin

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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

THURSDAY, NOVEMBER 3, 1881

A RECENT "FIND" IN BRITISH PALÆONTOLOGY

THE world is but rarely startled nowadays by the discovery of whole groups of new organisms from the rocks of Britain; it is only from the Far West that such surprises come. Two or three generations of active collectors have ransacked our strata so thoroughly that only now and then by some happy chance is a new vein of research opened, the finder of which may be congratulated rather on his good luck than on his special acuteness in observation. Such a vein has recently been struck by the Geological Survey among the Lower Carboniferous rocks of the south of Scotland. Some account of the more important features of this "find" may be of interest to the general reader.

Travellers who enter Scotland from the south, remark that after leaving the plains of the Tweed on the east side, or those of the Solway on the west, they find themselves in a range of hills or uplands, not lofty and picturesque indeed, but with sufficient height and individuality of feature to form a notable barrier between the valleys of the border on the one hand and the Scottish Lowlands on the other. This belt of pastoral high grounds, so bright with the glamour of poetry and romance, has a special interest to the geologist. He can trace it back to its origin about the close of the Silurian period, when it first began to rise out of the sea, and served, by its upheaval, to define one or more of the great inland basins in which the Old Red Sandstone was deposited. From that ancient time down to the present the ridge seems to have formed a barrier between the basins on its northern and southern margin. No doubt it has been enormously worn down in the general denudation of the country, deep valleys have been trenched through it; much of it has now and again been submerged and covered by masses of sedimentary material. Nevertheless it has preserved its existence. Lying along a line of terrestrial weakness, its strata, originally horizontal sheets of mud and sand, piled over each other to a depth of many thousand feet, have been crumpled and corrugated to a vast extent. The movements by which these contortions were produced have doubtless recurred at many intervals, so that we may conceive them to have in some measure, if not entirely, compensated by occasional elevation for the lowering of the level of the ridge by continuous denudation.

During the early part of the Carboniferous period these southern Silurian uplands of Scotland formed a barrier between the lagoons of the Lowlands and the more open waters to the south which spread over the north and centre of England. That the ridge was not continuous, or at least that there was now some water-way across it or round its end, between the basins on either side, is indicated by the similarity of their fossils. Yet that it formed on the whole a tolerably effective barrier is indicated partly by the marked difference between the corresponding strata on its northern and southern flanks, and partly by the singular series of organic remains to which attention is here called.

For some years past the Geological Survey of Scotland has been engaged in the detailed investigation of the Carboniferous rocks between the Silurian uplands and the English border. The whole region has now been mapped; the maps are partly published, and partly in the hands of the engraver for speedy publication. The rocks have been collected, and their chemical and microscopic analysis is in progress. Their fossils have been gathered from every available stratum, and have already been in large measure named and described. So that materials now exist for a tolerably complete review and comparison of the stratigraphy, petrography, and palæontology of the Carboniferous rocks of the Scottish Border. In the course of the work one particular zone of shale on the banks of the River Esk has been found to possess extraordinary palæontological value. From this stratum where exposed for a few square yards by the edge of the river a larger number of new organisms has been exhumed by the Survey than has been obtained from the entire Carboniferous system of Scotland for years past. As a whole the remains are in an excellent state of preservation. Indeed in some instances they have been so admirably wrapped up in their matrix of fine clay as to retain structures which have never before been recognised in a fossil state.

The more important treasures from the shales of Eskdale and Liddesdale are fishes, crustaceans, and arachnids. The fishes were at once placed in the hands of Dr. R. H. Traquair, whose devotion to fossil ichthyology has made him our *facile princeps* in this department of palæontology. The first part of his report on them, devoted to the Ganoidei, has been completed and is published by the Royal Society of Edinburgh (*Trans. Roy. Soc. Edin.* xxx. (1881), p. 15). He points out the extraordinary interest of the collection, both as opening up an almost entirely new fish-fauna, and as revealing remarkable structural peculiarities in many of the new forms. Out of twenty-eight species of ganoids no fewer than twenty at least are new. Of the sixteen genera in which these species are comprised five are now for the first time added to science (*Phanerosteon*, *Holurus*, *Canobius*, *Cheirodopsis*, and *Tarrasius*), of which one (*Tarrasius*) is altogether so peculiar that no place can be found for it in any known family. To the family of Palæoniscidæ fifteen new species and three new genera are added. The most abundant species is a form of *Rhadinichthys*, which occurs also on the north side of the Silurian barrier. Another fish of common occurrence in the latter region is *Eurynotus crenatus*, of which only a single scale has been found in the Eskdale and Liddesdale region. A third species common to the two sides of the barrier is probably *Wardichthys cyclosoma*. But with these and possibly one or two other exceptions, all the fishes in the southern area are as yet peculiar to it, while at the same time the common forms of the Lothians are conspicuous by their absence in Eskdale and Liddesdale. These facts suggest interesting problems in Carboniferous geography and in ancient zoological distribution.

Without entering here into structural details, we may refer to the peculiarities of one or two of the new forms described by Dr. Traquair. He proposes the term *Phanerosteon* for a genus of Palæoniscid fishes, possessing a fusiform body, apparently for the most part devoid of scales, with a peculiarly rounded off dorsal fin, and destitute of fin-fulcra. If the nakedness of the body be due not to the non-preservation of scales, but, as seems almost certain, to the original absence of them, we are here presented with a Palæoniscoid fish showing a condition of squamation almost identical with that of *Polyodon*. Only one species, but a number of specimens of it have been obtained. The new genus *Holurus*, though placed by its author among the Palæoniscidæ, offers in its non-bifurcated caudal and rounded long-based pectoral fin a contradiction to his definition of this family; but the cranial osteology is in the main so decidedly Palæoniscid that he prefers to regard the genus as standing most fittingly where he has put it. Two species are described. Still more aberrant from the typical Palæoniscidæ is the genus *Canobius*, which to the general configuration of the family unites a disposition of the suspensorial and opercular apparatus almost identical with that of the same parts in the Platysomid *Eurynotus*. Four species are described. But the most remarkable of all this singular group of fishes is included by Dr. Traquair in a new family, to which, from the more characteristic of two specimens having been found at the foot of the Tarras Water, he has given the name of Tarrasiidæ. *Tarrasius*, the typical and only known genus possesses rhombic, minute, shagreen-like scales, persistent notochord, well ossified neural and hæmal arches and spines, with the slender interspinous bones penetrating between the extremities of the vertebral spines as in teleostean fishes, and a long dorsal fin composed of closely-set jointed rays. Only two specimens, conjectured to belong to the same species, have as yet been obtained. Their state of preservation is such as to leave in doubt some important parts of the structure of this curious fish. It is to be hoped that future exploration in the same prolific locality may furnish Dr. Traquair with additional evidence on the subject, and enable him to complete his work.

Associated with the skeletons of the fishes are the remains of some new phyllopod and decapod crustaceans, which have been worked out by Mr. B. N. Peach, the Acting Palæontologist of the Scottish Geological Survey, who has described them in a memoir also communicated to the Royal Society of Edinburgh (*Trans. Roy. Soc. Edin.* vol. xxx. (1881) Part 1). The Phyllopods consist of two new species of *Ceratiocaris*, which differ from the Silurian species of this genus in having the body relatively much larger than the carapace. The numerous specimens are in a good state of preservation, one individual having been found with its intestinal canal distended with food. Of Macrurous Decapods several new species occur that differ in no essential respect from their living representatives. They belong to the genera *Anthrapalæmon*, *Palæocrangon*, and *Palæocaris*, upwards of forty specimens of one species of *Anthrapalæmon* having been obtained. Mr. Peach has worked out their structure with great skill. Among his observations is the occurrence of abundant minute calcareous calculi on the tests of these crustacea, precisely like those of the common shrimp.

One of the most singular features in our recent additions to the palæontology of the Lower Carboniferous rocks of the Scottish Border is the abundance in which the remains of scorpions have been discovered. The existence of these arachnids (*Eoscorpius*) in strata of this age in Scotland was made known some years ago by Dr. H. Woodward. But we are now in possession not of mere single and imperfect fragments, but of numerous and often admirably-preserved specimens which have enabled Mr. Peach to work out the structure of the insects in great detail. In anticipation of the early publication of his descriptions the following notes may be given here. He finds that these Palæozoic forms differ in no essential respect from the living scorpion so far as regards external organs. He has recognised in them every structure of the recent form, down even to hairs and hooks on the feet. The sting alone has not been certainly observed, but that it existed may be inferred from the presence of the poison gland which Mr. Peach has detected in the fossil state. The chief difference between the living scorpion and its ancient progenitors lies in the fact that in the fossil forms the mesial eyes are much larger in proportion to the lateral ones, and also to the size of the whole animal. The two mesial eyes are placed on an eminence near the anterior margin of the carapace formed by two converging tubes, and so arranged that the creature could look with them upwards, outwards, and forwards. There are at least four lateral eyes on each side. The mandibles, palpi, and four pairs of walking legs are beauti-

fully distinct on many specimens. The combs are much like those of the modern scorpion, but with a very remarkable sculpturing which at once recalls that so characteristic of the Eurypterids. The genital orifice, combs, and eight breathing stigmata occupy positions similar to those of the same organs in the modern scorpion. As regards theories of descent these fossils afford no more help in tracing the pedigree of the scorpion than is furnished by the living form, for it is obvious that the scorpion has remained with hardly any change since Carboniferous times. There can be little doubt that it is the most ancient type of Arachnid, whence the others have been derived.

Since the first specimens of scorpion were found by the Geological Survey among the Lower Carboniferous beds of the Border further research has brought many more to light from other and distant parts of the country. No fewer than five species belonging to a single genus (*Eoscorpius*) have been recognised by Mr. Peach, some of which must have contained individuals eight or ten inches in length. Most of these specimens, and also the crustacea and fishes above referred to, have been obtained by the Survey fossil-collector, A. Macconochie.

One further interesting fact deserves mention here. When the Geological Survey first began its work in Scotland, and was engaged in mapping the east of Berwickshire and Haddingtonshire, a remarkable and hitherto unique specimen was found there which was described by Salter under the name of *Cycadites Caledonicus*, as the most ancient cycad yet known. Among the specimens recently collected by A. Macconochie from the Border ground are several apparently of this same form which are so well preserved as to show that they are not plants at all. They occur together with species of *Eurypterus*, and are almost certainly a yet undescribed comb-like organ belonging to that creature. This fact, coupled with the singular eurypterid-like sculpture on the combs of the fossil scorpions, lends support to the suggestion which has been made that the eurypterids are ancestral aquatic arachnids.

ARCH. GEIKIE

THE HEAD-HUNTERS OF BORNEO

The Head-hunters of Borneo: a Narrative of Travel up the Mahakkam and down the Barito; also Journeyings in Sumatra. By Carl Bock (late Commissioner of the Dutch Government). With thirty Coloured Plates, Map, and other Illustrations. (London: Sampson Low, Marston, Searle, and Rivington, 1881.)

THIS large and lavishly-illustrated volume derives its chief value from the fact that the author is a clever [ar]tist, and that all the handsome coloured plates which [fo]rm the main feature of the book are evidently careful [dr]awings made on the spot, not imaginary designs con[stru]cted from more or less imperfect sketches or descrip[tio]ns. The houses, villages, and forest scenes are all true [to] nature, and the same may be said of the numerous [po]rtraits of the Dyaks and illustrations of their domestic [lif]e and customs. The figures are indeed wonderfully [lif]e-like and the drawing accurate, the only fault being [a] very slight tendency to Europeanise the features—a [ki]nd of personal equation due to Mr. Bock's artistic [stu]dies having been made from European models. This is visible in the small and well-formed mouths of the two women in Plate 16, and in the perfectly straight and well-developed nose of the "Chief of the Forest People" in Plate 24. When, however, he has taken special pains and has had ample time to finish his drawing, as in "Hetdung, my favourite Dyak Boy" (Plate 23), he avoids this fault, and gives us a portrait as perfect and as characteristic as a good photograph.

Mr. Bock went out to the East to collect birds in Sumatra for the late Marquis of Tweeddale, and spent about nine months in that island. He was then employed by the Dutch Government to make an excursion through the interior of Borneo, to report on some of the Dyak tribes and collect specimens of natural history for the museums of Holland. This journey, which occupied in its preparation and execution about six months, was partly over ground new to European travellers; first to the country of the Poonau Dyaks in about 1° 40′ N. lat., 116° 30′ E. long., and then up a western tributary of the Mahakkam or Koti River, and overland for a short distance to the head waters of the Teweh, a branch of the Barito or Banjermassin River. This watershed is in about 0° 5′ S. lat. and 115° 35′ E. long., and appears to consist of an undulating country with a few detached hills. It is however marked by a curious geological phenomenon very rarely met with in the tropics, a large area covered with huge angular rocks, of every shape and size and tossed about in the greatest confusion. It is called by the natives *Jalan batu*, or the Stony way, and our author's description of it will bear quotation:—

"Covering an area of several square miles, and cropping up as it were in the centre of a vast forest, this Field of Stones is well calculated to arouse the superstitious dread of a savage people. Here scattered in wonderful confusion like the remains of a ruined castle: there standing erect and orderly as if carved by chisel and levelled by plumb-line and square: some in ponderous masses as large as a house, fifty or sixty feet in height and of still greater width and thickness: others heaped like so many petrified cocoa-nuts, or like a pile of forty-pounder cannon-balls: here bare and gaunt like the pillars of Stonehenge: there moss-covered and decked with ferns or gorgeous flowers: in all directions for miles and miles the stones lie scattered. Some of them have assumed fantastic shapes, in which the imagination can easily picture a travesty of the human form, or of other familiar objects: others again are marked with quaint devices, where wind and rain have put finishing touches to natural cracks and crevices, and made them assume the appearance of deliberately carved inscriptions, like those seen on ancient weather-beaten tombstones—or rather, like the curious 'picture-writings' found on scattered stones and rocks in British Guiana and other parts of South America. . . . For miles our route lay through this wilderness of sterility and fertility combined—sometimes creeping between two parallel walls of stone, thrown so closely together that there was scarcely room to walk sideways; sometimes making a considerable *détour* to avoid a more than usually rough spot. In some places the earth was covered with small loose stones, most difficult and painful to walk over; in others, the ground seemed to be of solid rock, and great care was necessary in walking to prevent one's feet being fixed in one of the innumerable crevices, which were the more dangerous from being partially covered by vegetation. Many of the large stones were so lightly balanced on a small foundation that it seemed as if the exercise of a moderate force would be sufficient to overturn them."

Mr. Bock was at first inclined to attribute this phenomenal region to volcanic agency; but, considering that no earthquakes or volcanic phenomena occur throughout Borneo, and that these rocks are all "a rubbly limestone," he concludes that they owe their origin to "the denuding force of the torrential tropical rains, which have gradually bared the limestone deposit." This however is a very lame conclusion, and in no way accounts for the extraordinary way in which the rocks have been fractured and heaped over each other. The only sufficient explanation is to be found in the action of subterranean waters dissolving away the limestone rock and thus forming extensive caverns, the roofs of which have at length fallen in over a large area, and thus produced the unmistakable appearances of violent upheaval and fracture. This phenomenon is however very rare on so extensive a scale, and, so far as we can recollect, this Bornean "field of stones" is almost unique. The nature of the surrounding country is not described, but the locality appears to be a low and nearly level watershed between the lateral tributaries of two great river systems, so that there might be a subterranean drainage in two directions. In many other parts of Borneo there are indications of long-continued denudation, and it may be that the very absence of volcanic phenomena, and the consequent stability of the surface for long periods, has rendered possible the amount of uninterrupted subterranean denudation required to produce this mimic representation of great volcanic convulsions.

Mr. Bock gives us a pretty full account of the Dyak tribes of Southern Borneo and all that he could learn about them, and the general impression of his descriptions, aided by his life-like portraits and domestic scenes, is, that there is a wonderful similarity between all the chief tribes of this great island both in physical and mental characteristics, though there are many specialities in habits. In the south we find a decided indication of Pacific influence in the general practice of tattooing, in the custom of *pomali* or "taboo," and perhaps even in the practice of cannibalism by one tribe—the Tring Dyaks. In the south, too, the use of the blow-tube seems to be almost universal, whereas it is comparatively rare in the north; but in their general character and habits, customs, ideas, and superstitions, there is a practical identity which renders much of Mr. Bock's volume a repetition of what has been more fully and accurately described by St. John, Grant, and other writers.

We may however note a few of the more novel or interesting facts recorded Mr. Bock never saw an orang-utan, so that this animal is evidently far less abundant in the southern than in the north-western parts of the island. He describes the effects of a great drought in 1878—a year before his visit—which destroyed the forest-trees over large areas and caused the destruction of birds and game, and the failure of crops, to such an extent as to cause a famine, and this on the equator in an area of dense forest where rains are usually of almost constant occurrence. Almost the only amusing episode in the book is the account of an earnest attempt to discover the much-talked-of "tailed men" of Borneo. Tjiropon, an old and faithful servant of the Sultan of Koti, declared, in the Sultan's presence, that he himself had seen some of these people in the Passir country. He called them "Orang-bontoet," or tailed men, and added the usual statement, that the tail was from two to four inches long, and that the people cut holes in the floor to receive it, so that they could sit down comfortably! Mr. Bock thought this so absurd that he disbelieved the whole story, but the Sultan of Koti was greatly impressed by it, and it was decided to despatch Tjiropon on an embassy to the Sultan of Passir with a letter requesting him to send by the bearer two of the "Orang-bontoet." After a long absence he returned, and met the party at Banjermassin as agreed; but he was very crestfallen, and would say nothing except that he had delivered the letter, and had not been able to procure any tailed men. Thereupon the Resident of Banjermassin, at Mr. Bock's request, himself sent a party to Passir with a letter to the Sultan, requesting him to say if there really were any tailed men in his country, and what had happened to the former messenger. After twenty-five days' absence the party returned, with a message from the Sultan of Passir explaining the whole matter. It appears that the Sultan's personal attendants are known by the term "Orang-boentoet di Sultan di Passir"—literally "the tail-people of the Sultan of Passir." The Sultan declared he had never heard of any other "orang-bontoet." He was very angry at two of his suite being so unceremoniously asked for, and ordered the messenger to depart instantly on pain of being flogged—a threatened indignity which sufficiently accounted for poor Tjiropon's silence. When again spoken to, however, he exclaimed,—"Before Allah! I *have* seen the *Orang-bontoet* long ago, and have spoken to them, but I could not see them this time."

Among the few natural-history facts noted, are, the conspicuousness of the wild bees' nests "at variance with the almost universal habit among all animals to conceal their nests as much as possible." But these nests evidently come under the category of objects which exhibit warning colours, being sufficiently protected by the stings of their inhabitants. The remarkable tenacity of life of the *Loris tardigradus* is well illustrated in the following passage:—

"One day I wounded one, and knowing its tenacity of life I strangled the little animal, then cut it open and pierced its heart. An hour elapsed before I waited to skin it, and when I took down the body I found it still alive, its lovely eyes wide open. When, hoping to finally despatch it, I pierced its brain with a needle, it began to shriek, and still some minutes elapsed before it was actually gone."

An equal tenacity of life is found in the allied Galeopithecus, which could be killed neither by breaking the spine nor piercing the brain, and it is not improbable that the continued survival of these very ancient types in the midst of higher forms may be in part due to this extreme power of endurance.

The journal of the Sumatra expedition contains little of importance, and all that is new or valuable in the volume might have been well compressed into a couple of magazine articles or papers for the Geographical Society. The illustrations however furnish the real *raison d'être* of the book; and besides the portraits of natives already referred to, attention may be called to the plate "Crossing the River Benangan," which gives the very best and most accurate idea of an equatorial forest that the present writer has ever met with.

ALFRED R. WALLACE

BUTTERFLIES

Butterflies: their Structure, Changes, and Life-Histories, with Special Reference to American Forms. Being an Application of the "Doctrine of Descent" to the Study of Butterflies. With an Appendix of Practical Instructions. By Samuel H. Scudder. (New York: Henry Holt and Company, 1881.)

MR. SCUDDER'S great reputation as an entomologist will cause many readers to turn to this beautifully got up volume with eager curiosity. They will expect to find a tolerably full account of all those interesting and complex phenomena of metamorphosis, variation, dimorphism and polymorphism, protective colouration, mimicry, and distribution, for the elucidation of which no class of organisms offers such abundant and striking materials; while they might not unreasonably anticipate that the bearing of the whole series of these phenomena on the "Doctrine of Descent" would be clearly indicated and the necessary conclusions to be drawn from them strongly insisted upon. The first separate work ever published on the general history of butterflies, as distinguished from their classification or specific description, would naturally excite some such expectations as these; but those who have entertained such ideas will be disappointed, and may perhaps be inclined to give the book less credit than it really deserves. We will therefore briefly indicate its contents and point out a few of its merits and deficiencies.

The first four chapters—"The Egg," "The Catterpillar," "The Chrysalis," and "The Butterfly"—respectively, give a very good general account of the form and structure of the insect during the stages of its existence, and they are illustrated by a large number of very excellent woodcuts, many of which seem to be original. Then follow descriptions of the internal organs, and their transformations during development, and a good chapter on habits, illustrated almost exclusively from North American species. We now come to the more important and interesting part of the volume, and find chapters on "Seasonal Changes and Histories," "The Colouring of Butterflies," "Diversity of the Sexes in Colouring and Structure," "The Origin and Development of Ornamentation," "Ancestry and Classification," and "Geographical Distribution," the titles of which cover a wide range, and seem to include all the chief points required for a full exposition of the subject. The treatment however is by no means satisfactory, since it is a rare thing to find any fact even alluded to beyond the range of North American species; and though the valuable observations of Edwards and Riley are frequently referred to, the important researches of Weismann and Fritz Müller are hardly mentioned. Far more important however is the almost total silence on the whole question of protective and warning colouration in larva and perfect insects and the wonderful phenomena of mimicry, which play so large a part in determining both the forms and colours of insects all over the world, and which are so marvellously developed in butterflies. The absence of all these considerations renders the chapter on "The Origin and Development of Ornamentation" most unsatisfactory, since it is almost wholly devoted to suggestions as to the probable lines which have been followed in the development of the ornamentation, while we are left without any clue to the reasons for such special and wonderfully diversified results, or the laws by which they have been produced. Equally meagre is the chapter on "Geographical Distribution," which is treated solely from the point of view of the North American collector.

A more important fault than these deficiencies, in a work presumably intended for popular reading and to excite young American entomologists to a more complete study of their subject, is the very peculiar system of nomenclature adopted by the author, which, by the needless difficulties it will cause, must tend to disgust beginners with the whole study of natural history. The writer who has done more than any other person to facilitate the study of North American butterflies is Mr. William H. Edwards, who, besides a great work on "The Butterflies of North America," illustrated by fine coloured plates, has published, so recently as 1877, a complete "Catalogue" of the species. He is in fact *the* authority on North American butterflies, to the conscientious study of which he has devoted his life. When any such standard systematic work exists in a country, it seems to us the obvious duty of all who write popular books to follow its classification and nomenclature, not as endorsing their correctness, but simply to facilitate reference to works which every student *must* constantly refer to. Instead of doing so Mr. Scudder follows a quite different order in his systematic list of species, adopts a complex system of families, sub-families, tribes, and genera, mostly with unfamiliar names; and uses a generic nomenclature so totally unlike that of the above-named standard work, that out of a list of fifty-eight genera referred to in his volume only ten have the same names as those adopted by Mr. Edwards. As an example of the difficulty and confusion this must cause to a beginner we may mention that the North American species of the old genus Papilio are here given under five distinct generic names; Lycæna under the same number, and Argynnis under four. The family Papilionides, which Mr. Scudder retains, no longer contains the genus Papilio, after which it is named, because he transfers this name to our old friend the Camberwell Beauty, which he styles *Papilio Antiopa*. The old Satyridæ, or Meadow Browns, are now named Oreades, and they are placed at the head of all the butterflies instead of near the end, as in the works of Edwards and of all the old writers. This must be all the more puzzling, because throughout the body of the work these names are everywhere given without the least indication that they are not in universal use. Thus at pages 100–102 we have *Basilarchia Archippus* many times mentioned, with a reference to Riley. But that author always uses the old name *Limenitis disippus*, and in the copious index to his Missouri Entomological Report, just issued, the name Basilarchia is not to be found, neither does it appear, even as a synonym, in Mr. Edwards' "Catalogue"! No one will object to differences of opinion on questions of nomenclature, when kept to their proper place in strictly scientific treatises; but every one who has at heart the extension of a taste for natural history has a right to protest against such totally unnecessary difficulties being thrown in the path of beginners.

We regret having to speak so strongly in animadversion of a book which contains much interesting matter and much valuable information, which is written in a pleasant

style and is illustrated in a very attractive manner. But we feel that an opportunity has been missed of producing a volume which should open up one of the most marvellous pages in the book of nature, in a manner to interest a wide class of readers and attract many new votaries to the study of these most beautiful and in many respects most instructive members of the great class of insects.

OUR BOOK SHELF

The Quarterly Journal of Microscopical Science. (London: Churchill.)

THE twenty-first volume of the second series of the above journal—published during the four quarters of this year—lies in its complete form before us, and it seems to merit more than a passing record at our hands. The volume contains over 650 pages of text, and, besides woodcuts, thirty-four plates, many coloured, and the majority of double size; but it is not the quantity of the material, gratifying though it be to see that the British school is not wanting in this respect, so much as the quality of the contributions that we would call attention to. In the importance of its Memoirs this journal, now in its majority, may fully claim to rank on the level of the highest of those comparable to it published in Germany, and its editor and his assistants are to be congratulated on seeing that all the subjects coming under their province are so fairly dealt with. It is not proposed to treat here of the individual memoirs from a critical point of view—no one individual could write such a criticism—but as a general *résumé* of the work done. Slightly classified, vegetable histology and physiology is enriched by the papers on *Welwitschia mirabilis* by F. Orpen Bower; on the development of starch grains, by F. W. Schimper; on the water glands in the leaf of *Saxifraga crustata*, by W. Gardiner. As contributions to zoology may be mentioned the memoir by G. Busk on Polyzoa; by H. B. Brady on Reticularian Rhizopods; a most important paper on Limulus an Arachnid, by the editor; to embryology the researches of Lankester on Limnocodium, Scott on Lampreys, Wilson on Actinotrocha; to anatomy the memoirs, on the head cavities and nerves of Elasmobranchs, by Dr. Marshall; on the nasal mucous membrane, by Dr. Klein; on the Branchiate Echinoderms, by Herbert Carpenter; on the organ of Jacobson, by Dr. Klein; on the lymphatic system of the skin and mucous membrane, by Dr. Klein; on the Wolffian duct and body in the chick, by Adam Sedgwick; on the cranial nerves of Scyllium, by A. Milnes Marshall; and on the structure and significance of some aberrant forms of Lamellibranchiate gills, by Dr. K. Mitsuri. Nor must the papers by Mrs. Ernest Hart on the micrometric numeration of the blood corpuscles; by J. F. Dowdeswell on some appearances of the blood corpuscles; nor those by Dr. Cunningham on microscopic organisms in the intestinal canal, and Prof. Lister on the relations of micro-organisms to disease, be overlooked. The value of this volume will thus be apparent to the reader who knows of the subjects of which the above is a condensed list. One thing alone, to our mind, the volume needs, viz. a really efficient index to its valuable contents. The two pages and a half of index to these 650 pages of matter form an index only in name. Would it not be well to have an index volume published to the twenty-one volumes of this series, and then with volume xxii. commence a yearly index which would be both a help and a service to the student?

Essays on the Floating-Matter of the Air in Relation to Putrefaction and Infection. By John Tyndall, F.R.S., LL.D (London: Longmans and Co., 1881.)

TO reprint these essays in an easily-accessible form was a happy thought of the author's. It is of vast importance to the public at large that they should at least know what views are being held by a large majority of working and thinking men on the subjects of putrefaction and infection. Quite apart from the question of how germs originate is the question of what evils arise from their presence; and although, with most of those who have investigated the matter, we regard it as well proven that, except from a pre-existing germ, no new germ arises, yet we would be prepared almost to overlook this part of the matter in our anxiety to see proper notions diffused as to the effects produced by these "floating matters of the air." The benefits that mankind has gained by the researches of the biologist, chemist, and physicist into this subject are already beyond calculation; nor is there yet any apparent limit to them. From the pages of this small volume some ideas may be gleaned of what the modern treatment of surgical cases has gained by a knowledge of this subject; nor do we think the day far distant when medicine may reach to the rank of surgery through an insight into the germ causation of febrile disease. The history of the silkworm disease in Italy and France bears witness to the enormous value, even if measured in a commercial sense, of the labours of Pasteur, Quatrefages, and others in working out from this point of view the parasitic diseases that caused at one time the almost total destruction of the silk industry in Europe; and the history of Pasteur's researches on fermentation, even when told in a few words, as in the fourth chapter of this volume, does it not tell of discoveries full of benefit to one portion at least of mankind? Prof. Tyndall well writes: "The antiseptic system of surgery is based on the recognition of living contagia as the agents of putrefaction." Keep these away, destroy them either by an excess of cold or heat, and the putrefaction is prevented. But this is true not of surgery only; it makes itself felt in the routine of every-day life. An account was laid before the Academy of Sciences of Paris, in May of this year, of an examination of the feeding-bottles in use at a *crèche* in Paris. The milk for the children put into these contracted a nauseous odour. Of thirty-one examined, twenty-eight contained in the caoutchouc tubes or nipples germs (microscopical microbes), and even in some cases there were masses, more or less abundant, of fungoid vegetations. The milk found remaining in some was acid, with numerous bacteria; and this in spite of what was thought to be cleanliness. No wonder Prof. Tyndall writes of such material—such matter out of place—as dirt. We cannot all contrive to live in the grand, pure air to be found in such places as the Bel Alp; but all could help towards making the air of their dwellings freer from the contagion of dirt; and if right and accurate notions were held on such matters by all interested in them, prevention would soon be seen to be much better than cure. This little volume will be found exceedingly interesting reading, and its contents will furnish the reader with abundant material for thought, which perhaps may, in floating through his brain, take root there and bring forth a crop of good fruit.

E. P. W.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Struggle of Parts in the Organism

MR. ROMANES, in his letter published in your number of Oct. 27 (vol. xxiv. p. 604) draws a distinction between the "Argument from Design as elaborated by the Natural Theologians of the past generation," and another argument from design which he

attributes to me, and which he describes as a "metaphysical" teleology—the idea of "an ultimate design pervading all nature, and blending into one harmonious Cosmos the combination and co-ordination of physical causes."

The first of these arguments from design he says he has a right to contest in your columns and to represent as "subverted" by Mr. Darwin: whilst as regards the second of these arguments from design, he admits the truth of my position that "no possible amount of discovery concerning the physical causes of phenomena can affect it."

I am not able to accept this distinction, or to withdraw on the strength of it my protest against the original communication of Mr. Romanes. The distinction is, in my opinion, purely imaginary and fallacious. The fundamental proposition of all arguments from design is simply this: that the exquisite adaptations to special ends which are conspicuous in organic nature are, and can only be, the work of physical forces when these are under the combination and direction and control of Mind.

But the whole force of this general proposition, and the whole power of it to produce conviction, depends on its applicability to particular cases of adaptation. There may be, and there are in nature, a few cases of apparent adaptations and of orderly arrangements of a very simple kind which do not necessarily suggest Mental Purpose. They may be the effect of what we call accident, or of the action of elementary laws under no guidance or direction. Inorganic phenomena furnish many examples of such arrangements. Even among organic things there may be a few examples of them. But in the special and elaborate adaptations of organic structures to their particular work and function, the human mind recognises the operation of mental faculties having a fundamental analogy with its own. Mind is a known agency, producing well-known effects. These effects can be recognised with as much certainty as the effects of any material force acting by itself. The Argument from Design is founded on this recognition. The writers of the last generation were perfectly right in resting the general Argument from Design on the separate instances of adaptation in which the mark of Mind is most signal and conspicuous. I hold, as they held, that each particular instance of adaptation which cannot be due to chance, and which cannot be due to the uncombined action of elementary forces, is "a separate piece of evidence pointing to operations of special design."

Mr. Darwin's theory of Natural Selection no more touches this argument than his hand could touch the fixed stars.

When Sir Charles Bell wrote his beautiful and classical Treatise on the Hand, he knew that the hand of every individual man has been "developed" in the womb. He knew that in the course of that development it passed through many successive stages. He knew that the vital processes concerned in this development were organic processes forming part of "natural law." But it never occurred to him to imagine that the "law" under which such intricate and wonderful adaptations were reached was a "law" in which Design had no part, or over which Mental Purpose had no control. He saw in physical causation the instrument of Mental Purpose, and not its rival or its enemy. He knew, moreover, the close relations between the hand of man and the less perfect, but the equally adapted structures of the same limb in the lower animals. He knew, farther, that the theory of Evolution had been started, and that just as individuals were born and grew, so it was suggested that all Animal forms had been born of each other, and that the Human Hand was the result of a long gestation in the womb of Time. He alludes to these theories and sets them aside—not as being untrue, but as being immaterial to his argument. And he was right.

Mr. Romanes is much mistaken if he supposes that the present generation is satisfied with the purely materialistic explanations of adapted structures which are erroneously supposed to be the final result of Mr. Darwin's theory. So thoroughly dissatisfied, on the contrary, with these explanations is the mind of the present generation, that it is breaking out in revolt against them along all the line. The old school of Theism is as alive as ever, and is as ready as ever to appropriate every new fact into the structure of its well-worn defences. And outside this school—among men who reject Christianity altogether, and who sit loose from every known theology—a conviction has arisen that somehow—by whatever name it may be called—Mind is indeed "immanent" in nature, working everywhere with an awful and an abiding Presence.

This view has been supported of late in Germany in a powerful argument by an author whose philosophy may seem grotesque, but who certainly has at his command all the resources of scientific knowledge, and who accepts and incorporates every fact which has been established in the whole field of biological investigation.

I wish Mr. Darwin's disciples would imitate a little of the dignified reticence of their master. He walks with a patient and a stately step along the paths of conscientious observation. No fact is too minute—no generalisation is too bold. But for the most part the whole is kept well within the limits, actual or supposed, of physical causation, and the rash dogmatism on higher questions of Philosophy and Theology which are common among his more fanatical disciples, are "conspicuous by their absence" in his writings. ARGYLL

It will be instructive to many, I doubt not, as to myself, to receive from Mr. Romanes an explanation of the precise sense which he attaches to the phrase "a general law whose operation is presumably competent to produce" any set of phenomena.

No one is more desirous than I am to see science freed from all theological complications; and it seems to me that every one who speaks of laws as "governing," "controlling," "regulating," or "producing" phenomena, is really mixing up ideas belonging to two entirely distinct categories.

That in the *purely scientific* sense, a "law of Nature" is nothing more than a general expression of a certain set of uniformities which the intellect of man discerns in the surrounding universe—that such a law holds good just so far as it has been verified, and not necessarily any further—that it accounts for nothing, and explains nothing—and that the power of prediction which it is supposed to give, depends entirely on an *assumption* of its universality, which may or may not be justified by facts—was the teaching of the great masters (Herschel, Whewell, and Baden-Powell), who aimed to form correct habits of thought among what half a century ago was the "rising generation" of scientific men. And as all subsequent writers on the logic of science, from J. S. Mill to W. Stanley Jevons, have taken the same view, I venture to think that it rests with Mr. Romanes to show that there is anything in the *law* of Natural Selection (which is simply the generalised expression of the *fact* of "the survival of the fittest"), that places it in a different category from every other.

The whole series of expressions to which I have taken exception may be regarded either as a "survival" of the theological conceptions by which science was formerly dominated, or as the result of a very common confusion between a "law" of science and a "law" of a state. For a "law" can only "govern," "control," "regulate," "produce," or exert any kind of *coercive* agency, when there is a power to give it effect; the "law," in that sense, being simply the expression of the will of such governing power, divine or human, as the case may be.

But as science (and in this I am quite at one with Mr. Romanes) knows nothing of such "metaphysical" conceptions, I cannot but think that it would be much better that scientific language should be cleared from expressions that have no meaning at all, if it be not one based upon them.

If I have not made my meaning sufficiently clear, I may refer any one who wishes to see this matter more fully discussed to my paper on "Nature and Law," in the *Modern Review* for October, 1880. WILLIAM B. CARPENTER

56, Regent's Park Road, N.W., October 29

P.S.—I regret that my reference to what Mr. Simon (in his address on Public Medicine at the International Medical Congress) designated as "the very remarkable series of facts" adduced by Dr. Creighton in support of his view of the communicability of bovine tuberculosis to man through the medium of milk, should have been so worded as to make it appear that Dr. Creighton accepts the doctrine of Klebs as to the "micrococcus" origin of tubercle, his dissent from which he had explicitly recorded. As Mr. Simon spoke of Klebs' doctrine as having been "solidly settled and widely extended" by the recent researches of Schüller, and as Dr. Creighton's difficulty of conceiving "a neutral (?) living organism" to be "charged with the power of conveying complex details of form and structure from one body to another," affords no *dis*proof of it, there seemed to me no occasion, in writing for the general public, to take any special notice of a point which Mr. Simon, in addressing a professional audience, had thought it better to pass without mention.—W. B. C.

An Alleged Diminution in the Size of Men's Heads

ALLOW me to draw the attention of your readers to a statement which is certainly strange, if true. An opinion is prevalent in the hat trade that the size of men's heads has undergone a decrease within the last thirty or forty years. The following statement has been given to me by a hatter whose name has attained a pre-eminence of a duration of more than one generation. "Five-and-thirty years ago," he says, "when I was a young man, we used to purchase hats for retail trade in the following ratio:—

Sizes	$21—21\frac{1}{2}—22—22\frac{1}{2}—23—23\frac{1}{2}$ inches.
Relative number ...	0— 1 — 2— 4 — 3— 1

At the present time," he adds, "I am selling hats in this ratio:—

Sizes	$21—21\frac{1}{2}—22—22\frac{1}{2}—23—23\frac{1}{2}$ inches.
Relative number ...	3— 4 — 3— 1 — 1— 0"

A manufacturer writes: "I should say that heads generally are two sizes less than at the time you refer to. A head of more than twenty-four inches' circumference is now quite a rarity, whilst we make thousands of hats for heads with a circumference of about twenty-one inches." I have received similar statements from other members of the trade, both wholesale and retail, and therefore feel that no further apology is required for bringing them under your notice. Accepting the statement *quantum valeat*, I have endeavoured to ascertain whether I could find any explanation or confirmation thereof. I have not succeeded, and therefore venture to ask information or opinions through your columns. The statement comes to me not only from men of experience in the trade, but from men of intelligence and observation exercised beyond the limits of the shop or the factory. It is, I am informed, extensively believed among hatters; it may, nevertheless, be merely a general impression. The diminution, it is said, is observed mostly among grooms and men of that class in the social scale. If this be really the case the change should be noticeable also among soldiers. The diminution is possibly more apparent than real, and may be traceable to alteration in the style of hair-cutting, or of wearing the hat. It has been suggested to me that men of the present generation have from birth smaller heads, dependent upon an alteration in the dimensions of the female pelvis, in consequence of modern fashion in dress. Of this opinion, however, I obtain no confirmation from eminent obstetricians of whom I have made inquiries. The statement then, as it stands, is wanting in explanation, and calls for further investigation. I may here quote the reply sent me by Prof. Flower to my question as to his opinion on the statement made by the hatters "that men's heads were smaller than they were twenty years ago":—

"Before drawing any important conclusion from such a statement it would be necessary to know much about the authority upon which it is made. Who, for instance, are the hatters that make it? Do all hatters concur in the same statement? Is it a mere general impression, or is it founded upon actual arithmetical data? Does it refer to any particular class of men, and does it refer to the same class of men? If it should be true, may it not arise from some change of fashion (if only founded upon the size of the hat, and not of the head) other even than the one you suggest, of hair being worn shorter—such as hats being worn more on the top of the head than formerly (in old-fashioned prints one sees the hat well down over the ears, which is certainly not the case now), or perhaps hats of the kind specified being now worn by a different (perhaps lower) class of the community, or by younger people? All these questions must be considered, and perhaps other sources of error eliminated which may not occur at first, before the statement can be accepted. If the evidence of the statement appears to bear investigation it would be well worth while following it up, as, if true, it would be one of the most remarkable facts with which I am acquainted, that in the space of twenty years a material diminution in the average size of the heads of the same population has taken place —a fact so contrary to all theory and to all experience."

For my own part I confess to some degree of scepticism as to the FACT, and should be glad of an explanation of this, probably only apparent, diminution in the size of men's heads.

Little Park, Enfield, October 26 W. B. KESTEVEN

The Evolution of the Palæozoic Vegetation

I AM pleased to have elicited the opinion of so distinguished an authority as Prof. Williamson upon Saporta and Marion's work, and his criticisms, even where antagonistic, will also, I am sure, be received by them with pleasure. Prof. Williamson holds views regarding the interpretation of some of the plant remains which are at variance with those held by most French geologists; but were the correctness of all his views conceded, I do not think Saporta and Marion's theory of the evolution of plants would thereby fall to the ground. A vast array of fact, which is not controverted, has been brought forward in a very able manner, and a connected and well-considered theory as to the nature of the modifications that have led through Cryptogams to Phanerogams is for the first time presented in a concise and lucid manner; and I think few will agree with the professor in deprecating such work because knowledge of the older floras is still incomplete. J. S. GARDNER

The Teaching of Practical Biology

IN the interesting introductory address of Prof. T. Jeffery Parker at Otago there is an omission which I am sure my friend would be the very first to wish to have rectified. In speaking of that remarkable development of the teaching of practical work in biological laboratories which will no doubt have a very considerable influence on the pursuit of this branch of science, Mr. Parker makes reference to the considerable services which have been rendered by Professors Huxley and Ray Lankester; but he forgot to say that one who, unfortunately, is no longer among us, provided for systematic teaching in practical work some time before Prof. Huxley was enabled to bring his wishes to fulfilment. The characteristics of this line of study were made known to the general zoological world in 1870, when Prof. Rolleston published his "Forms of Animal Life, being Outlines of Zoological Classification *based upon Anatomical Investigation* and illustrated by Descriptions of Specimens and of Figures." Prof. Rolleston's system was well enough shown in his preface to that work, where there occurs the following sentence, which I beg leave to quote as germane to this question:—"The distinctive character of the book consists in its attempting so to combine the concrete facts of zootomy with the outlines of systematic classification as to enable the student to put them for himself into their natural relations of foundation and superstructure."

October 29 F. JEFFREY BELL

The Igneous Rocks of Iceland

LAST year a friend and I rode round the north and west sides of Iceland, and from my observations then I cannot doubt that the conclusions to which Dr. J. Geikie has arrived concerning the south-west of the island apply equally to the more northerly parts. The glacier-scorings on the older lava were especially marked in a district unexplored except by a few Icelanders, and known as the Storisande or Big Sand. This desert lies to the north of Ball's Jokul and Lánge Jokul, and between Arnevatn and the River Blanda. As we crossed the undulating surface of the old lava, pale and ruddy in colour, the contrast was very striking where the black basalt seemed to rise from the plain in jagged cliffs up to the ice-field which caps these ranges. Where the sand was blown off this pale lava there were the lines of glaciation clearly engraved. The trend of the desert as a whole was towards the north, and the lines of glaciation ran north and south. In the Husavik district we saw, besides these two lavas, the lava of the present century, including that of 1875.

A. J. HUBBARD

1, Ladbroke Terrace, Notting Hill, W., October 31

Replacing Flint Flakes

WITH reference to the replacing of flint flakes on Palæolithic implements it may be of interest to your correspondent, Mr. W. G. Smith (NATURE, vol. xxiv. p. 582), to learn that I have succeeded in building up a core out of Neolithic flakes. When searching the sandhills at Dundrum, Co. Down, last August, with my friend Mr. J. S. Hyland, I noticed a number of flakes of a similar colour lying on the slightly raised shingly beach on which the sandhills stand, at a point where the sand had apparently been recently blown away. Seeing from an imperfection in the stone that several fragments had formed part of the same flint, I collected all the pieces I could find, some of which were at a yard or two's distance from the rest. Without much trouble I was able the same evening to put them together, and have so fixed twenty-two flakes into position, forming about three-fourths

of the original pebble. The operator had first broken the pebble into two halves, and then chipped two-thirds of one half away in flakes, of which I found thirteen; the remainder of that half he threw down as useless. Of the other half I have nine flakes, and one is missing; the unbroken remainder is also gone. Perhaps the workman threw it away to a distance in disgust, as he does not seem to have got a single satisfactory flake out of the whole flint. The appearance of the half which I have almost complete is extremely like the illustration of the core made up out of a modern flint-knapper's flakes in Evans' "Stone Implements," except that the crowns of the flakes are triangular instead of quadrangular. There are the same small interstices between the crowns of the flakes, showing that the blow splinters off on each side of the bulb of percussion a small fragment, as well as the flake itself. This explains why the average concavity on the core is slightly less than the average convexity of the flake at the top of the bulb of percussion. F. ARCHER

Crosby, Liverpool

Climate of Atacama

SOME practical evidence as to climate has come forward at the shareholders' meetings of the northern Railways of Chile, the Coquimbo, Tongoy, and Carrizal and Cerro Blanco. In each of these districts torrential rains have occurred, which are all reported as unexampled. Long residents state that rain was formerly little known, and such was my observation in connection with the district. One reason why the weather is deserving of attention is that no change has taken place in the water-surface or vegetation. A similar change to rain in the Suez and Cairo district is attributed to the Suez Canal, but it is a matter worthy of consideration whether we are not really entering on a cycle of change. So far as Atacama is concerned, if at any former period there were rains, the conditions of habitation must have been different from those which have been so long considered to apply to the rainless district. HYDE CLARKE

PHYLLOXERA CONGRESS.—Dr. E. R. F. wishes to know where he can obtain a full report of the recent Phylloxera Congress at Bordeaux.

SCIENTIFIC INSTRUMENTS (J. S. MARSTON).—We cannot undertake to commend any particular instrument maker; you should get the lists of the leading makers, whose addresses you will find in our advertising columns.

HOLLOWAY COLLEGE.—So far as we understand this is not a charitable institution: Miss S. should write to the authorities at the College, Staines.

EFFECTS OF COLOURED GLASS (E. M.).—It is owing to the law you refer to.

THE AUTUMN SKY

I.

MANY and varied must ever be the regrets that attend the departure of summer days and summer pleasures; and their remembrance casts a lingering sadness even over the bright and beautiful hours that often alleviate the approach of sterner and gloomier seasons. Such impressions however are not shared alike by all. Few perhaps altogether escape their influence; but in some classes they are softened or even obliterated by the development of interests and pleasures of a very different description. Such is especially the case with the astronomical observer. The shortening of the twilight hours is to him as the withdrawing of a veil that obscured the minuter, yet not least interesting, features of the glorious scenes that he loves to explore; and he views with fresh pleasure the deepening tone of the background of unfathomable space, as the atmospheric illumination fades steadily away. We cannot indeed in our latitudes rival the transparent purity of the south, that gives such a magnificent depth to the aspect of the firmament, and throws out in such radiant brilliancy the host of heaven; yet even our autumnal skies are so great an advance upon the misty softness of the summer's night that the observer cannot but rejoice in their return.

These remarks are very obvious, not to say somewhat late in their application, when the sun has already advanced so far upon his downward way: yet they may not be entirely inappropriate when we are about to draw attention to some of the present characteristics of the sky. Much now in every direction invites the inquiring gaze, and an early hour challenges the opening of the observatory, or the arrangement of the telescope. Eye-pieces should be cleaned, adjustments rectified. Instruments of all kinds and sizes may be called into profitable and pleasant requisition—let the possessors only make the best of what they have. If we do not see more than we anticipate, though that may sometimes happen among the uncertainties of the English climate, yet we shall surely see enough to amaze us at the greatness of the Creator.

From its pre-eminent brightness, the planet Jupiter will naturally be the first object of attention. Belts we shall expect to find traversing his great broad disk, for they are very seldom absent; but there also we shall encounter a more unusual object, the ruddy patch, which has been sometimes described as vermilion, possibly from "personal equation," but which to most eyes exhibits a cinnamon or brick-red hue. There it has been, with scarcely any appreciable change, for the last three years[1]—a degree of permanence equalled, and even surpassed, by some dark spots in ancient days, but singularly contrasted with the general mutability of the markings of the disk. What is that spot? and where is it situated with regard to the real surface of the planet? Is it mere superficial colouring? but if so, of what material? Or is it an opening in the great mass of clouds—or what we call such—that is thought to envelope this colossal globe? But if so, how strange that its outline should have remained so steadily permanent. And in that case, as it is difficult to suppose it at the same level with those dark grey bands which have been ascribed to a similar absence of vapour, shall we place it above or below them? We might infer the former, if it is the case, as has been said, that it is more easily traced up to the limb than the dark belts; but the observation is delicate, and the effacing of the grey bands in that situation is not matter of universal consent. We might possibly conceive, on other grounds, admitting that the dark belts do indicate a deep clearing of vapour, that ruddy tints are caused by something at a higher level, because these are occasionally suffused over the whole equatorial zone and its markings, so as sometimes even to affect the general colour of the planet to the naked eye. The interposition of trees has prevented the writer hitherto from observation this year, but the accompanying sketch, taken 1879, November 12, with my 9⅓-inch

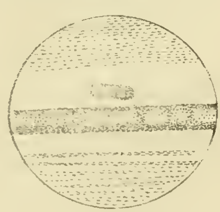


FIG. 1.

"With" mirror, may perhaps be of some interest in comparison with the observations of the present season.

The image, it will be noted, is telescopic, *i.e.* inverted.

[1] Traces of it may be detected in the Earl of Rosse's observations in 1873; but it seems to have been unnoticed in the interval.

The red spot was suspected to consist of two confluent masses, as well as to be somewhat inclined to the neighbouring belt; but the former idea, at least, not being confirmed by other observers, was probably owing to the inferior atmospheric conditions, which did not admit of a power much above 100. The central girdle consisted as usual of three divisions: the N. broadest and darkest, and of a cinnamon hue; the equatorial zone pale grey, with very feeble transverse interruptions, an indistinct continuation of the "portholes" so conspicuous some years previous; the S. band grey also, but deeper in tone. The N. hemisphere, beyond a bright region, had many faint grey stripes: towards the opposite pole was a feeble brownish shading; so that the colouring of the disk as a whole was, in heraldic language, "counterchanged." On other occasions very singular tints have been noted by eminent observers—yellow, full blue, and crimson; and the subject well deserves study, even though, as seems likely, that study should lead to little of a satisfactory nature.

Then there are other markings to be investigated on that great disk, both luminous and dusky, and that in another aspect, with a view to the determination of rotation; for, strange to say, it is found that some small dark specks travel more rapidly than other bright ones, and that the red spot moves slowest of all. And thus it is that the uncertainty in the axial velocity of that vast globe, first noticed by Cassini more than two centuries ago, is almost as far from being removed as ever; and, on the whole, one is tempted to question whether, after all, we have a single accurate idea, excepting that of mutability, concerning that enormous surface; and whether, if we could be transported there, we should not be surprised at the baselessness of all our conjectures. Certainly it may be said as to Jupiter, and not as to Jupiter only, that the recent advances in optical power and observing skill have only served to make more evident the thickness of the veil that obscures these objects in mystery. Analogy leads us a little way safely enough, but only to desert us before long. However, we must patiently watch and wonder.

Other matters, too, might be noted before we take our leave of that brilliant disk, so easy of investigation, so difficult to interpret. Why are the shadows cast on it by the satellites sometimes so black, at others so dim, or so abnormally small? Why, when a satellite passes behind the limb, is it sometimes neatly bisected by it, at others visible behind or through it, either from optical projection, as stars have been seen in front of the moon, or from the partial transparency of the edge of the globe? And then the satellites—they, too, have their anomalies in differences of apparent magnitude and brightness, due perhaps to variable obscurations of surface, but, if so, indicating conditions totally unlike that of our own satellite—the presence of considerable atmospheres, the possible want of coincidence between their periods of revolution and rotation—or even a superficial constitution as mutable and as hard of interpretation as that of the primary whom they obey.

We shall not remove our telescope far before a still more interesting and surprising object will present itself in Saturn, now especially suited for investigation, both as to altitude and the presentation of the ring. If there was much in Jupiter to perplex us, there is far more here; and it is rather mortifying to remark how little advance in knowledge has been made by the great increase, in recent years, of telescopic power. But little is ascertained now, beyond what was detected by the perfect vision of Dawes with his 6⅓-inch Merz object-glass, or the beautiful definition of the 15-inch achromatic, by the same maker, at Harvard College. A study, in fact, of the memoir by Bond and his associates, in the *Annals* of that college, vol. ii. part 1, published in 1857, would be the best preparation for an intelligent scrutiny of this planet. But not much beyond a general impression can be expected from ordinary telescopes. It will require considerable power, as well as light and sharpness, to detect Encke's subdivision of the outer ring (which, however, I caught in 1880 with my 9⅓-inch mirror), to trace any possible subdivisions of the inner ring, to ascertain whether, as Trouvelot thinks, the gauze veil is becoming less transparent in its outer portion, or to investigate those strange and puzzling outlines of the shadow of the ball on the rings, which, noted in part by others, have been recorded in detail in the Harvard memoir. A copy is here given of one, but not perhaps the most remarkable, of their diagrams.

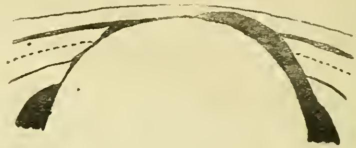


FIG. 2.

Such a contour could be only accounted for, if at all, by an amount of unequal thickness in the ring, which ought to be, but is not in the smallest degree, visible in the edgeways presentation. The success of Prof. Hall in detecting a bright spot of considerable permanency upon the ball encourages attention in that direction—especially as there are several previous records of such phenomena. To hunt for the smaller satellites with any but superior instruments would of course be waste of time, but it may be remarked that Enceladus has been seen by Ward with exceptionally keen sight and a 4·3 inch Wray object-glass, by Franks with 5 inch ditto, by Pratt with an 8·15 inch "With" mirror, and by myself with 9·33 inch. Mimas, the innermost, has been detected with a 7-inch achromatic by Wray. Meyer at Geneva has found it of late nearly as bright as Enceladus, and thinks it may be variable.

The morning skies at present are graced by Venus, not however a remarkable object in her gibbous phase; and Mars, who is coming rapidly round by his opposition to the evening. The smallness of his diameter, about 15″, is a great impediment, especially in the English sky, to the hope of success with his minor details, though it may be borne in mind that in the air of Milan, and with an admirably defining Merz object-glass of 7¼ inches, Schiaparelli has made many delicate observations on a scarcely larger diameter, and with exceptionally fine air has carried them down, strange as it may appear, to a diameter of only 6″.

The only other of the larger planets now visible is Neptune, easily picked up by means of an ephemeris, and distinguishable from a fixed star, even in a small telescope, by its dull and steady light. It demands, however, a large aperture for the bringing out and sharp definition of its pallid disk; in the latter respect the great achromatics at Rome (9·3 inch) and Bothkamp (11·5 inch) were unsuccessful, but I have seen it neatly terminated with Huggins's 15-inch object-glass. Its satellite, though glimpsed by Ward with a 4·3-inch achromatic, is far too difficult for ordinary vision or common apertures; I have seen it however plainly with the 15-inch just mentioned.

Vesta, though possibly visible with the naked eye, is a mere brilliant point of less than 1″ in the telescope.

Some notes on the autumnal constellations will be brought forward in a subsequent paper.

T. W. WEBB

(*To be continued.*)

METEOROLOGY OF BEN NEVIS

THE cairn on the top of Ben Nevis marks, as is well known, the highest spot in the British Islands, and when the question of high-level meteorological observations came to be seriously entertained some years ago, attention was drawn to this position as the best afforded in these islands for a first-class meteorological observatory which would form one of the more important members in the network of the high-level stations of the Continent. The advantages of the situation are enhanced by the consideration that the mountain rises directly from the level of the sea to a height of 4406 feet, and that its summit stands from 2000 to 3000 feet clear above the mountain ridge to westward which lies between it and the Atlantic. The mountain thus raises its head in the very midst of the west-south-westerly winds from the Atlantic, which exercise so preponderating an influence on the meteorology of Europe. Among the results from observations made at this elevated situation the more important to be looked for are those which relate to the greater movements of the atmosphere, particularly the upper currents in their relations to the cyclones and anti-cyclones of Europe, the data for the investigation of some of the laws regulating these movements being obtained by a comparison on the one hand of observations made on Ben Nevis with those made at the other high-level stations of Europe, and on the other with those made at lower levels, and published in the different Daily Weather Reports.

When therefore the Scottish Meteorological Society (last spring) accepted the handsome offer of Mr. Clement L. Wragge to ascend Ben Nevis every morning in time to make observations on the top at 9 a.m., every care and precaution was taken as regards the quality of the instruments procured, and in the arrangements made for their exposure and protection, so as to make the observations first-class, as far as this could be secured without constant residence on the top or the erection of continuously recording instruments. Further, as it is contemplated to build an observatory on the top, the arrangements regarding the instruments and their positions were carried out, so that all that will be required to complete the observatory is simply the erection of a suitable residence for the observers.

That Mr. Wragge possessed not only enthusiasm, but also strength of will, skill, and readiness of resource, was soon manifested. He met the Council of the Society in Edinburgh on May 26 and 27, was in Fort William on the following day, and on Tuesday, the 31st, fixed and secured the instruments in proper position on the top of the Ben, including a massively-built cairn for the reception of the barometer. On June 1, at 9 a.m., the observations were regularly begun, and have since been continued without the break of a single day up to the disastrous storm of October 14. This continuity, so extremely desirable in such a series of observations, was guaranteed by Mr. Wragge securing at the outset the services of a well-qualified assistant, whom he trained to the work, as well as a second assistant, whom he also trained, to meet any emergency that might arise.

The instruments are these:—A barometer inclosed in a cairn, 6½ feet high and 17 feet in circumference, which incloses a strong box fastened with lock and key, with a second door protecting the box from heavy rains and the gusts of wind which blow up the narrow gullies of the tremendous precipices, 1800 feet high, only a few paces off, and sweep over the instruments with terrific fury. A Stevenson's screen, with maximum, minimum, dry and wet-bulb thermometers, the bulbs of which are 4 feet above the mountain stone; the box opens to north, and also contains the ozone tests. The other instruments are a terrestrial minimum radiation thermometer, a solar maximum radiation thermometer, 4 feet high, and a rain-gauge, 8 inches in diameter, and its rim 1 foot high. Fig. 1 shows Stevenson's thermometer screen in elevation, erected on four stout posts, having angle-sloping stanchions, by which the box was securely and immovably fixed.

This arrangement continued till the end of July, when, as the tourist season was then setting in, a more effectual protection of the thermometers was necessary, so as to prevent the possible occurrence of any crowding of tourists immediately around the thermometers, or any other interference which might vitiate the readings made daily at so heavy an expenditure of time and trouble. In order to afford the required protection, Mr. Stevenson designed a strong wire cage, measuring five feet each way, the wire-netting being supported by strong iron rods continued downwards beyond the cage, and bent below at right angles. The horizontal projecting rods below are weighted with heavy blocks of stone, so as to secure complete stability to the structure. In the interior of the cage the Stevenson screen, with the thermometers and ozone tests, is placed, and firmly secured with supports.

Fig. 2 is a sketch of the station, kindly prepared by Mr. Wragge, which will explain, better than any verbal description could do, the arrangements which have been carried out with regard to the instruments, and also the remarkable character of the plateau at the top of Ben Nevis. A is the barometer cairn; B, the wire cage, with the thermometer screen seen inside; C, the solar maximum radiation thermometer, a black-bulb in vacuo, the terrestrial radiation thermometer being placed on one of the stones adjacent; D, the rain-gauge; and E, the hut, covered

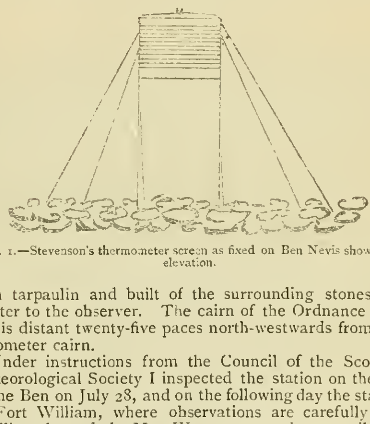


FIG. 1.—Stevenson's thermometer screen as fixed on Ben Nevis shown in elevation.

with tarpaulin and built of the surrounding stones for shelter to the observer. The cairn of the Ordnance Survey is distant twenty-five paces north-westwards from the barometer cairn.

Under instructions from the Council of the Scottish Meteorological Society I inspected the station on the top of the Ben on July 28, and on the following day the station at Fort William, where observations are carefully and intelligently made by Mrs. Wragge as nearly as possible at the same instant of time that observations are made at the top and at the different points on the outward and homeward journeys. We left Fort William about half-past five on Thursday morning, the party consisting of Mr. Wragge, Dr. Sanderson, the Society's honorary treasurer, Mr. R. C. Sanderson, and myself, as well as Mr. Wragge's Newfoundland dog, Renzo, that daily accompanies him in his ascents. The instruments are read at Fort William before starting, and the first observation on the journey is made at a peat bog, which was reached at 6.12 a.m., Mr. Wragge dismounting and reading his aneroid and sling thermometer, and noting the wind, clouds, and other observations of the weather. The lake was reached at 7.23 a.m., where the third set of observations were made, including the temperature of the water of the lake, which was 48°.3, being 3°.0 higher than that of the air. Here our ponies were left, and Mr. Wragge pushed on, in order to reach the top in time for the regular 9 a.m. observation, while we followed more at leisure.

Fig. [illegible].—The Summit of Ben Nevis.

The fourth set of observations were made at the spring, which is about 800 feet from the top, the temperature of the spring being 37°·4. Observations are again made at these same points on the homeward journey, which, together with the three at the top at 9, 9.30, and 10 a.m., make a daily series of ten observations, independently of those made at the same times by Mrs. Wragge at Fort William, and at other times in the afternoon and evening. In addition, extra observations are also made, such as when entering or emerging from the cloud-fog, when the wind suddenly changes in direction or force, &c., these being made from their important bearings on general atmospheric circulation. These observations, which are taken with scrupulous regularity, evince on the part of Mr. Wragge the most undaunted devotion to his work, particularly in consideration of the extreme discomfort they often entail, since to make them he must dismount not unfrequently in a piercingly cold storm of wind and rain.

The following are the observations made on July 28, at 9 a.m., by Mr. Wragge, and also those made at the same time by Mrs. Wragge at Fort William:—

	Ben Nevis, inches.	Fort William, inches.
Barometer at 32°	25·434	29·931
Aneroid	25·355	—
Max. Thermometer	36·8	54·0
Min. ,,	32·5	49·2
Dry bulb ,,	35·0	53·5
Wet bulb ,,	35·0	50·3
Solar max. ,,	94·0	—
Terres. min. ,,	32·2	—
	inch.	inch.
Rainfall	0·200	0·069
Wind, direction	South westerly	South westerly
,, force (0–12)	3 to 4	4
Cloud-fog (0–10)	10	9

We reached the summit shortly before eleven, the last 1000 feet of the ascent having been through a dense cloud-fog, which clung persistently to the mountain the whole time we were on it. We found the protecting wire cage in its position, having been placed there on the previous day, but the Stevenson screen was still in the position it had occupied since the observations began, and as is shown in Fig. 1. A reading of the instruments having been made, the workmen proceeded to remove the thermometer-box to its new position inside the wire cage, as represented in Fig. 2, and the party withdrew to the hut, which, though containing only one apartment, 8 feet by 4 feet, and its walls far from wind-tight, afforded a most welcome shelter from the bitterly cold masses of mingled fog, Scotch mist, and sleety drizzle which drifted across the mountain. A fire was quickly lighted in the middle of the hut with splinters of wood and balls of tow steeped in paraffin, the excessive dampness of everything rendering the use of paraffin indispensable. The inspection which followed showed that the full equipment of instruments were in excellent order and in excellent positions, and that the observations were made with a precision and a fidelity which left nothing to be desired.

At the time of our visit everything was drenched with wet. On opening the thermometer-box the whole inside presented the appearance of having been just lifted out of water, a drop hanging from the bulbs of the dry and other thermometers. Mr. Wragge informed us that during the fifty-one days preceding our visit the dry-bulb thermometer was found on opening the box to be without the drop hanging from it only on six occasions.

A noteworthy feature of the meteorology of Ben Nevis is the winds. Repeated instances were seen, during the ascent and descent, of a thin filmy fragment of mist suddenly appearing over one of the glens, which on being watched was observed slowly to ascend, lengthening and becoming denser as it rose, frequently assuming in time an appearance resembling the smoke rising from a burning mountain. On one occasion the whole of that

part of Glen Nevis seen from our position was clear of cloud and mist, but in a brief space of time, not exceeding five seconds, a dense mist suddenly filled the whole breadth of the glen, the upper limit of the cloud-fog being only a little lower than the level of our position. These facts point to ascensional movements in the atmosphere over Ben Nevis, which in all probability are caused by the temperature of the surface of the mountain being higher than that of the enveloping atmosphere at the same heights. These ascensional movements are disturbing influences on the winds prevailing on the Ben, but especially at the top, the result being that it is frequently difficult, if not impossible, to say what the true direction of the wind is, as it is found to blow from all points of the compass within the space of a few minutes.

In the accompanying sketch (Fig. 2), Mr. Wragge has given a faithful representation of the surface of the plateau of the summit. This plateau consists of about ninety acres, the difference of level between any two points of which does not exceed ten feet. It is throughout strewn to a depth of about four feet, with blocks of felstone lavas and volcanic agglomerates, nearly all tilted up to such a degree that the only mode of progression is over the sharp edges of the stones. These blocks are different from the rock of the mountain itself, the nearest rock resembling them being found in Glencoe, twelve miles distant. No soil is anywhere visible, the heavy rains doubtless having long ago washed it all down hill; indeed, except in small detached patches, the mountain is wholly bare of soil for the last 1500 feet of the ascent.

That the striking bareness of Ben Nevis is due to the excessive rains having washed away the soil, and not to the climate, is shown by the remarkably well-grown specimens of *Cerastium alpinum*, *C. trigynum*, *Saxifraga stellaris*, and *Alchemilla alpina*, which were found at heights closely approaching 4000 feet in situations which protected the soil from being carried away by the rains. In a small patch only 240 feet from the summit, I gathered a small grown specimen of *Saxifraga stellaris* in flower, and in the same patch there was growing a Carex, which however showed no flower. Excepting the above flowers and *Sagina saxatilis*, *Carex rigida*, *Luzula spicata*, and a single specimen of *Sibbaldia procumbens*, I did not notice any other flowering plants which a botanist would take the trouble to put into his vasculum. The scanty flora of Ben Nevis as regards the rarer species is thus in striking contrast to the rich floras of Ben Lawers and many others of our Scottish mountains, a circumstance which may perhaps possess some geological significance.

ALEXANDER BUCHAN

THE ELECTRIC TRAMWAY

ONE of the most interesting sights in connection with the Exhibition at Paris is the electrical tramway; it is a practical evidence of the great future in store for electricity as a motive power. From an article in *La Nature* we give some of the leading features of this recent application of electricity. In the case of a tramway the question is a complicated one, for the rails cannot be isolated, and they therefore cannot be used as

FIG. 1.—Siemens' Electric Tramway; Departure Station at the Place de la Concorde.

conductors. How then, in these conditions, is the motor of the carriage connected with the fixed generator placed in the Exhibition at the Palais de l'Industrie? This is the problem which MM. Boistel and Sappey, the engineers of Messrs. Siemens, have completely solved, after several fruitless attempts, which almost always precede successes of this kind. In the preliminary experiments made at the workshop in the Rue Picot, they made use, as conductors, of a brass tube electrically connected with the carriage by a traverser, the function of which we

shall explain; the wheels and rails will serve as the return wire. This system worked well at the *workshop.* In practice a special difficulty was encountered. The dirt sticking to the rails and felloes of the wheels formed a sort of crust so insulating as to prevent adequate communication with the earth. The increase of resistance produced by this interposition of finely conducting bodies was often sufficient to arrest the vehicle. The remedy was happily beside the evil, and a second conductor was established parallel with the first, in communication with the second pole of the generator, on which runs a second traverser, identical with the former. These two cars follow on their respective tubes the movements of the vehicle, and ensure a good and constant communication between the electrical generator and the motor. Fig. 1 represents the carriage and the station at the Place de la Concorde. At the height of the knife-board are seen the two conducting tubes supported at certain distances by posts, and in the intervals by iron wires, like the floor of a suspension bridge. The carriage is exactly the same as the ordinary tramway car. The motor is placed underneath the feet of the inside passengers; it is a Siemens dynamo-electric machine, with horizontal inductors similar to that which produces the current in the Palais de l'Industrie. The distance traversed is about 500 metres, and is accomplished in one minute. The work expended reaches 8 horse-power in the curved

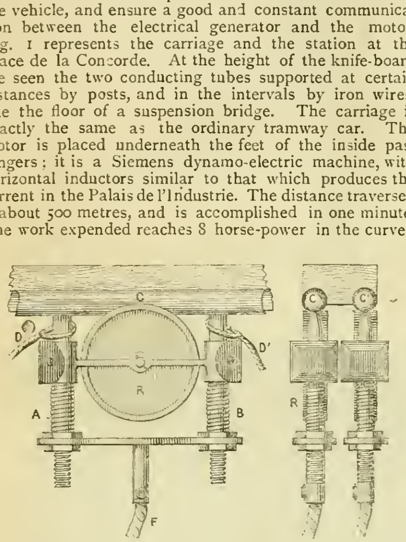


FIG. 2.—Traversers conducting the current to the carriage.

part; on a level straight run it does not exceed 3½ horse-power. The transmission of motion to the wheels is effected by means of a fall-chain. By a happy coincidence, which belongs to the very nature of the electric motor, the *static effort* is maximum when the motor is in repose. This renders the starting very easy, and no difficulty is met with from this point of view. To regulate the speed, resistances are introduced into the general circuit, which reduces the intensity of the current, and consequently the work of the motor; this operation is very simply effected by means of a lever placed at each end of the carriage. For stopping, the current is broken, and at the same time an ordinary brake is applied.

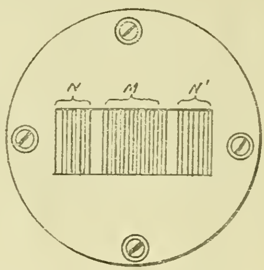
As to the mode of communication of the conductors with the carriage, we have said that it is effected by means of two identical traversers; it will suffice to describe one of them. Fig. 2 represents in detail one of these traversers. It is composed of a rectangular frame, bearing in its centre a wheel, of which the groove R is semi-cylindrical, and is applied against the exterior part of the conductor C, formed of a brass tube 22 millimetres in diameter and slit on its lower part along all its length to a breadth of about 1 millimetre. In this tube slides a cylindrical core of 12 centimetres in length, on which are fixed, at its extremities, two vertical shafts, A, B, which support the wheel or roller. Two springs supported on these vertical shafts press the wheel against the tube, and maintain an elastic contact between the tube and the wheel. The carriage may then be moved; the wheel runs against the tube, the core glides in the interior, without the communication ceasing to be, if not perfect, at least quite sufficient for the purpose. Only at times a few sparks are seen at the moment when the carriage passes the coupling of the tubes; these sparks are due to small instantaneous ruptures of the current which do not affect the regular working of the system. The experiment shows that the wear and tear scarcely affects the tube, and bears almost entirely on the core placed in the tube; but nothing is easier than to replace a core. The current reaches the machine by the copper conductor F. The traction of the carriage is effected by the cords D or D', according to the direction.

The electric railway of the Palais de l'Industrie presents the first practical solution of an electric traction in the case of a tramway. Of course it is easy to see how this application of electricity is capable of the greatest development, and that by modification of details the principle might be applied to railways.

THE BOLOMETER

AN instrument a thousand times more sensitive to radiant heat than the thermopile, and capable of indicating a change of temperature as minute as 1-100,000th of a single Centigrade degree, deserves the attention of the physicist. When to these qualifications it can be added that the new instrument is far more prompt in its action, and more reliable than the thermopile for the *quantitative* measure of radiation, then, indeed, no apology is needed for a detailed description. The instrument is termed by its discoverer, Prof. S. P. Langley, the *bolometer*, or *actinic balance*. The earliest design of the in-

FIG. 1.

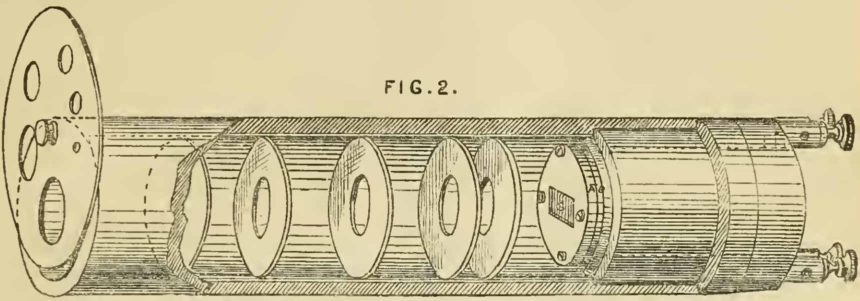


ventor was to have two strips of thin metal, virtually forming arms of a Wheatstone's bridge, placed side by side in as nearly as possible identical conditions as to environment, one only of them being exposed to radiation. Such radiation would slightly warm the strip and therefore alter its electric resistance, and the amount of this change would be indicated by the movement of the needle of the galvanometer placed in the middle circuit of the "bridge." For various reasons iron was eventually chosen as the material for the thin strips, as it combines the qualities of tenacity and laminability, with a greater sensitiveness in its electric resistance to temperature changes than either gold, platinum, or silver. Preliminary experiments made with a simple strip of iron in comparison with several delicate thermopiles showed the advantage of the new method of investigation A large Elliott thermopile of sixty-three pairs, a very sensitive thermopile of sixteen small pairs, and a delicate linear thermopile of seven pairs of elements were selected. The iron strip taken was 7 millims. long, ·177 millims. broad, and 0·004 millims

thick. Its resistance was 0·9 ohm. The three former instruments were one after the other connected with a short-coil mirror galvanometer of sufficient delicacy. The same galvanometer was used in the bridge, the three resistances used with the strip being respectively ·9, ·4, and ·4 ohm, and the total current employed being a little over half a weber. The result showed the sensitiveness of the three instruments and of the strip to heating by radiation to be respectively as 1, 4·1, 16·3, and 226·3.

The actual bolometer embodies the principle of the preliminary experiment with various additional refinements. Sheets of *steel* (palladium and platinum can also be used) are rolled out until of a thickness of from ·01 to ·002 of a millimetre is attained. Out of these sheets small gratings are cut or punched, having the individual bars about 1 millimetre wide and 1 centimetre long. Two systems of strips are arranged so that the current from a suitable battery divides itself, half passing through each, the interposed galvanometer showing no deflexion when the two currents are of equal strength. Fig. 1 shows the general arrangements of the gratings of strips. A rectangular opening is cut in a disk of ebonite of 3 centimetres

FIG. 2.

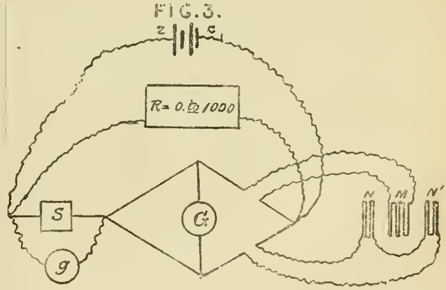


diameter. A second disk of the same size is clamped behind it, and between the two the gratings or systems of strips are fixed. That system which is to be exposed to radiation is placed in the centre of the rectangular opening at M. It consists of fifteen strips, eight of them being in front, and seven at a little distance behind. The second system is divided into two halves, N and N′, on each side of M, each half consisting of seven similar strips, four in front, three behind. Every joint is soldered, and the resistance of the fourteen strips in N N′ is made up equal to that of the fifteen strips in M by the interposition of a short wire in the circuit. M is placed in one arm of the bridge, and N N′ in the other, as indicated in the diagram of Fig. 3.

To protect the bolometer from air-currents, sudden changes of temperature, and from danger in handling, it is inclosed in a cylinder of ebonite lined with sheet copper. This is represented in Fig. 2, where the tube is drawn partly in section to display the interior. At the anterior end of the tube is a revolving diaphragm with suitable apertures. Within, a number of cardboard diaphragms or stops are placed, being retained in position by rings of ebonite tube between them. Behind these is the grating G of the bolometer fixed between the two disks of ebonite A and B. At the back there is a layer of solid non-conducting material, through which the conducting-wires pass to the two terminals. In the posterior end of the case are contained the resistance-wires by which to bring the two systems to equality; this being advisable because, if they are unequal at the beginning of the experiment, though they can be balanced by taking proportionally unequal resistances in the other arms of the bridge, according to the well-known law, any general rise of temperature will produce a *greater increment* of resistance in the system whose resistance is at first greater, producing a continuous "drift" in the galvanometer needle. Fig. 3 shows the connections of the bolometer and the bridge. A battery of one or more Daniell's cells, Z, C, provides a current the strength of which is controlled at will by changing the resistances in a box of coils, R, arranged as a shunt to the bridge-circuit. The working current is measured by a shunted galvanometer, *g*, and the two systems of strips M and N N′ of the bolometer are connected to their respective places in the bridge by four insulated wires twisted together and covered with flannel. A modification of the usual formula enables the change of resistance of M to be calculated from the currents observed in the galvanometer G.

The results of the new instrument are somewhat startling. A sunbeam one square centimetre in section will, according to Prof. Langley, warm one gramme of water 1° C. in one minute. It would therefore raise a sheet of water 1-500th of a millimetre thick, and 1-10th

FIG. 3.



of a square centimetre in area, $83\frac{1}{3}$° C. in one second, supposing all the heat to be retained. And as platinum has a specific heat of only ·032, the same sunbeam falling on a strip of platinum of these dimensions should, on a similar supposition, raise it in one second to 2603° C., a temperature sufficient to *melt* it! This result is, however, prevented by the re-radiation which the strip almost instantaneously exerts.

An examination of the heating effect of rays from different portions of the spectrum of solar radiations was made, but under conditions different from those of the measurements made by Müller, Herschel, and Tynda

These experimenters worked with spectra obtained by prisms of quartz, rock-salt, and other refractive substances. Prof. Langley used the far purer spectrum obtained by reflection from the surface of one of Rutherford's diffraction-gratings ruled on speculum-metal. This showed the result that *the heat-maximum* (of solar rays) *in a normal spectrum is not in the infra-red rays, but is at least as far up the visible spectrum as the orange near the D-line.* This result is so important that we append the figures. In the upper line are the wavelengths of rays in millimetres; in the lower the corresponding reduced galvanometer deflections.

λ	·00035	·0004	·0005	·0006	·0007	·0008	·0009	·0010	·0011
δ	12	55	207	256	198	129	80	58	41

[The H line in the violet has λ = ·00039; the D line in the orange has λ = ·00059; and the A line at the end of the visible red has λ = ·00076.]

We give the above figures as stated by Prof. Langley; but we cannot help remarking that if these were obtained by letting sunlight fall upon strips of *polished metal* they cannot be accepted offhand as a true representation of the facts of solar radiation, as they merely in that case indicate the position of the maximum of *the rays absorbed by the metal surface employed.* A blackened surface would without doubt tell a very different tale and show a maximum for other rays.

In conclusion it may be pointed out that the fundamental principle of the bolometer is identical with that of Siemens' electrical pyrometer, where also changes of temperature are measured by changes in the electric resistance of a conductor. But though the principle be identical the application is quite novel; and we must congratulate Prof. Langley on the skill and ingenuity with which he has applied an unpromising principle to the construction of this most interesting and most promising instrument of research.

S. P. T.

NOTES

THE announcement will be received with regret that Prof. Huxley, in consequence of the pressure of other duties, has been compelled to resign the Secretaryship of the Royal Society. It is believed that Prof. Michael Foster will probably be his successor.

SIR C. WYVILLE THOMSON has not yet resigned the chair of Natural History in Edinburgh University, though we regret to learn that he is likely to do so in a few days.

THE arrangements for the Crystal Palace Electrical Exhibition are progressing very satisfactorily. Major Flood Page has gone over to Paris to put himself in direct communication with the different administrations there and with the largest exhibitors. Applications for space have been very numerous, especially from English manufacturers. The Postmaster-General has signified his intention of sending all the apparatus now in Paris, and in addition there will be a considerable accession of modern apparatus in use in the Post Office Telegraph Department. The display will be essentially a display of the electric light. The whole of the building will be divided off and illuminated by the different inventors and manufacturers of lamps. The new Edison light will be shown in operation in the Concert Hall, and very great interest is evinced in the public display of this light. The effect produced by it in Paris was quite startling, and it is generally believed that Mr. Edison has solved the problem that he set himself, viz. to produce a light to supersede gas in our houses.

THE success of women in the late Honours Examinations of the University of London in Arts, Science, and Medicine was very remarkable. In the conjoint Honours Examination in Mathematics for candidates for the 1st B.A. and 1st B.Sc. Examinations Miss Charlotte A. Scott obtained the first place in the first class, with marks qualifying for an exhibition. In the 1st B.A. Honours Examination in English subjects Miss M. L. G. Petrie obtained a precisely similar position, whilst two other ladies, Misses C. A. J. Cl[illegible]ner and H. E. Clay, were also placed in the first class. In the 1st B.A. Honours Examination in German, Misses A. Page and H. H. Brown were placed in the first class, the former qualifying for a prize. Miss F. H. Prideaux actually carried off the supreme honours in Human Anatomy at the Honours Examination of the 1st M.B., being placed first in the first class, and being awarded the Gold Medal in Anatomy. In the Honours Examination in Materia Medica and Pharmaceutical Chemistry Mrs. M. A. D. Scharlieb attained a place in the first class.

THE first meeting of the one hundred and twenty-eighth session of the Society of Arts will be held on Wednesday, November 16, when the opening address will be delivered by Sir Frederick J. Bramwell, F.R.S., chairman of the Council. The following are among the papers which will be read during the session:—The American system of heating towns by steam, by Capt. Douglas Galton, C.B., F.R.S.; practical hints on the manufacture of gelatine emulsions and plates for photographic purposes, by W. K. Burton; stained glass windows, by Lewis Foreman Day; photometric standards, by Harold Dixon; telephonic communication, by Lieut.-Col. C. E. Webber; the causes and remedies of bad trade, by Walter R. Browne, M.A.; the native tribes of the Hudson's Bay Territories, by Dr. Rae, F.R.S.; the manufacture of ordnance, by Col. Maitland; some practical aspects of recent investigations in nitrification, by R. Warington; the production and use of gas for purposes of heating and motive power, by J. Emerson Dowson; gas for lighthouses, by John Wigham (illustrated by an exhibition of some of the gas flames and apparatus used in lighthouses); the relation of botanical science to ornamental art, by F. Edward Hulme, F.L.S., F.S.A.; the storage of electricity, by Prof. Silvanus Thompson, D.Sc.; the high-pressure steam-engine, by Loftus Perkins; the industrial resources of Ireland, by J. Philips Bevan; a new chemical compound, and its application to the preservation of food, by Prof. Barff, M.A.; the distribution of time by a system of pneumatic clocks, by J. A. Berly; tonnage measurement, by Admiral Sir R. Spencer Robinson, K.C.B., F.R.S.; tools and cutting edges, by D. A. Aird; the teaching of forestry, by Col. G. F. Pearson; the art of turning, by P. W. Hasluck. The usual short course of Juvenile Lectures, given during the Christmas holidays, will be by Mr. W. H. Preece, F.R.S., the subject being "Recent Wonders of Electricity." The following are the subjects of the courses of the Cantor lectures for the session just about to commence:—First course, on some of the industrial uses of the calcium compounds, by Thomas Bolas, F.C.S.; second course, on recent advances in photography, by Capt. Abney, R.E., F.R.S.; third course, on hydraulic machinery, by Prof. John Perry; fourth course, on book illustration, old and new, by J. Comyns Carr. In connection with Capt. Abney's lectures, it is intended to arrange for an exhibition of photographic apparatus, processes, &c. These lectures originated in 1863, with a bequest to the Society of Arts by the late Dr. Cantor. Since that date three or more courses have been given every session, each course dealing with some application of science or art to industry or manufactures.

WE understand that Mr. Donald McAlister, Fellow and Lecturer of St. John's College, Cambridge, has undertaken to prepare for Messrs. Macmillan and Co. an English edition of Prof. Ernst Ziegler's "Text-Book of General and Special Pathological Anatomy," which is on all hands regarded as the standard authority on its subject. The book will range with Dr. M. Foster's "Text-Book of Physiology," Gegenbaur's "Comparative Anatomy," and other works published by the same firm.

The eminent Italian geodesist, General Marquis J. Ricci, of Genoa, died at Novara on September 27, at the age of seventy years. The geodetic methods of Gauss, Bessel, and Baeyer were introduced into the geodetic work of Italy in great part through General Ricci, who was one of the original members and for long president of the Italian Commission for measuring the European degree.

It is stated that Mr. Robert Hart, C.B., Inspector-General of Chinese Customs, is getting a series of elementary science works translated into Chinese. Many foreign books have already been translated into that language, but they have been intended either for the higher officials or for the students at the free Government schools. Mr. Hart however intends, it is said, to endeavour to have the present translations circulated amongst all classes of the people; and his high official position would doubtless give him facilities for this purpose not possessed by any other foreign servant of the Chinese Government. It was, we believe, owing to the enlightened exertions of this gentleman that the *Tungwen*, or Foreign College of Peking, was extended so as to embrace a scientific curriculum, as well as to train interpreters in foreign languages, which was its original aim. From a recent calendar it appears that this institution now has nine foreign professors, besides numerous native tutors, and is attended by 102 students. One department of the College is devoted to the preparation of books for the diffusion of scientific and general knowledge. This is said to have been kept in view as a prominent object from the beginning. Among the scientific subjects taught we find chemistry, natural history, mathematics, animal physiology, and astronomy. Students who display conspicuous merit are entitled to the first step of the nine degrees of official rank. They are then appointed to the discharge of official functions in connection with some leading department of the Government, but they are required to continue their studies at the College as "resident graduates." A complete course lasts for eight years, the first three of which are given exclusively to foreign languages, and the remainder to the acquisition of scientific and general knowledge. Most of the students, moreover, as they are intended for a special service, receive a stipend varying with the length of their study, but which never exceeds about 3*l.* a month. This is certainly a good sign of the value attached by the rulers of China to Western knowledge; but everything does not present the same roseate hue in that country. We read that the line of telegraph erected from Soochow to Shanghai is being opposed by the agriculturists, who are placing all manner of obstacles in the way of the workmen employed. They pull up and destroy the poles, thinking that they act against the Fheng-shui, or geomantic influence, and are likely to lead to spiritual complications. Troops are stated to have been despatched to protect the line. Doubtless in time these deeply-rooted prejudices, which stand so much in the way of real internal improvements in China, will pass away; at present it must be acknowledged with regret that they are as living and active as ever. We notice that telephonic communication is about to be extensively employed in the large foreign settlement at Shanghai.

Lovers of Japanese porcelain will be glad to hear, on the authority of the Consul-General of the United States in Japan, that the modern productions will in time, if indeed they do not already, far surpass the older manufactures of Satsuma, Owari, Imari, and Kutani wares. The chief want of Japanese porcelain is regular symmetry in the pieces, and uniformity in a set or number of pieces. The absence of these is due, he says, to the fact, that machines or forms for moulding are not used, and the ovens are so defective that the heat is not evenly distributed. The native manufacturers are now manifesting much interest in the improvement of their wares. At one place the clay pits are said to have been worked for two thousand years or more, and the deposits seem scarcely more than scraped. Cobalt, used in colouring, is found in the same hills. The total value of the earthenware and porcelain exported from Japan to foreign countries during last year was valued at nearly one hundred thousand pounds sterling.

With the *Bilderschriften des Ostindischen Archipels und der Südsee*, Dr. A. B. Meyer begins the first part of a serial publication, which promises to be of great value to anthropologists. The distinguished curator of the Dresden Zoological Museum has undertaken, with the assistance of the Department of the Arts and Sciences, to issue a series of fac-similes, photographic or otherwise, of the most important objects in the extensive collection entrusted to his charge. This first part of the comprehensive project is devoted to the pictorial writings from Malaysia and the Pacific Islands, of which either the originals or exact copies are preserved in the Dresden Museum. As a detailed account of the series will be given on its completion, it will suffice here to state that the present number contains six folio photographic plates of the curious and hitherto undeciphered hieroglyphics or pictorial writings from North Celébes, the Pelew Islands and Easter Island. These are accompanied by eight folio pages of letterpress full of extremely interesting matter. For although no direct attempts are made at interpreting the texts, all previous essays of any value are collected, as well as such local myths or legends as may be likely to suggest a key to the interpretation of the writings. These are partly on wooden tablets, partly on prepared bast, partly also on the lintels and doorposts of the native houses that have been brought bodily to Europe. That they are all true writings, and not merely so much conventional ornamental work, a careful study of these plates will convince the most sceptical. Both the illustrations and the letterpress are produced in the sumptuous style characteristic of such publications in Germany.

The Committee on Photometric Studies appointed by the Board of Trade, have issued their report. Among other things they recommend that, for the determination of the illuminating power of coal gas, the use of the sperm candle should be discontinued, and that, for the future, Mr. Harcourt's air-gas flame, as defined in the appendix to the report, should be employed instead, as a means of affording with constancy the light of one average sperm candle. And in the event of any other mode of measuring the illuminating power of coal gas, such for instance as some modification of Messrs. Keates and Sugg's lamp or Mr. Methven's lamp being resorted to on account of its practical convenience, this other mode of measurement should be standardised, and from time to time checked, by comparison with Mr. Harcourt's air-gas flame, which should alone be taken as the official standard. The details of the experiments and evidence, on which the recommendations are based, are given in an appendix. These experiments were mostly conducted under the Committee's direction by Mr. Harold B. Dixon, the secretary to the Committee.

A Jamaica correspondent writes that Mr. Maxwell Hall, M.A., F.R.A.S., has succeeded, with some aid from the Local Government, in establishing a regular system of meteorological observations throughout the island, and a summary of these is published monthly in the *Jamaica Gazette*. A daily telegram is also sent round the island, giving results of readings at the chief stations, and any premonitory hints that may be considered necessary in view of telegraphic information from the United States signal stations at Key West and Cuba. Thus both shipping and agricultural interests are well prepared for any storms or hurricanes that may be expected. "Mr. Maxwell Hall's work," our correspondent writes, "though not yet fully recognised by the Government, is carried on in a most commendable spirit, and there is no doubt that when the benefits of regular and trustworthy meteorological observations are apparent,

and Mr. Maxwell Hall's numerous contributions to astronomical science are more fully appreciated, we shall have in Jamaica a properly equipped meteorological department, doing valuable work in this region, in which the distribution of hurricanes, and sometimes earthquakes, have so important a bearing on human life and the general prosperity of the island." A Weather Observatory, we learn from the *Jamaica Gleaner*, has been established by Mr. Hall at the Government Cinchona Plantations, at the residence of Mr. Morris, director of the Botanical Department, who has undertaken voluntarily to give it personal and daily attention. This observatory is at a height of 4900 feet.

SPARROWS have multiplied to such an alarming extent in South Australia that a Commission appointed by the Government have sent in a report recommending means to be taken for their destruction, and rewards to be given for heads or eggs.

MR. J. H. WILLMORE, of Queenwood College, near Stockbridge, Hants, writes under date November 1: "A 'Storm-Petrel was found not far from here on Sunday week. The little bird was lying on its back on the top of a hedge, and had evidently been dead some days. On opening it one side of its body was found to be black, as if it had died from a blow. I imagine the very rough weather had driven it inland, and it had come into contact with one of the trees close by. These birds are, I believe, very rarely found so far inland, and, so far as I can learn, this is the first instance in this neighbourhood."

MR. PARK HARRISON has published, through Quaritch, an interesting account of an incised slate and various other objects discovered in an old structure at Towyn, Merionethshire. The slate is covered with many curious figures, evidently cut by the hand of man; and these Mr. Harrison endeavours to interpret. There are numerous illustrations, including an autotype reproduction of the slate itself and another with only the figures clearly brought out.

SINCE 1869 the Otago (New Zealand) Acclimatisation Society has, we learn from the *Colonies and India*, liberated 157,041 young trout, and has sent 135,110 trout ova to various parts of Otago. Since 1874 it has liberated 34,900 salmon fry, and in 1879 and 1880 it liberated 790 perch and 60 tench. Young American "White-fish" (*Coregonus albus*), let loose in the lakes in the Rotorua district about two years ago, have been recently met with by the natives; but as soon as it was discovered what the fish were they were returned to the water. The natives are delighted at the discovery. The Auckland Society has, through want of support, been compelled to sell by auction its stock of animals and plants.

THE Brighton Health Congress and a "Domestic and Scientific Exhibition" will be held in the Pavilion Dome and Museum in the second week of next month. The president of the Congress is the Earl of Chichester, and the president of the Exhibition is Dr. B. W. Richardson.

M. LOEWY, sub-director of the National Observatory of Paris, has been appointed by the Government to report on the state of French provincial observatories, which have recently received a credit of 4000*l*. from the French Parliament. These establishments are five in number:—(1) Marseilles, directed by M. Stephan, with MM. Borelly and Coggia and two computers, has a credit of 1250*l*. The principal work is observation of nebulæ by Stephan, revision of Rumker's catalogue, discovery of comets and small planets, study of intra-Mercurial planets by Borelly, determinations by the Gauss method of absolute magnetic declination, &c. (2) Toulouse Observatory, directed by Baillaud, with a budget of 880*l*. and a municipal subvention of 200*l*. for printing the observations. A magnetic pavilion has been built with compass constructed by Brümer. The principal work is the observation of sun-spots, cataloguing variable stars, and observation of August meteors; not less than 1300 were tabulated on the last occasion of their appearance. (3) Bordeaux, directed by Rayet, with a credit of 1200*l*. The regular work has not yet begun, but observations have been made on comets and the red spot on Jupiter. (4) Lyons, directed by André, the credit given by the Government being 800*l*.; the amount of subvention paid by the city is not stated. The principal feature of this observatory is its connection with three meteorological stations situated in the vicinity—one at Tête d'Or, the second at Mont Verdun, and the third at Ampius. The regular astronomical work has not yet been begun. (5) Algiers, directed by M. Trepied, has a credit of 1500*l*. from the Government. The principal work has been the observation of Jupiter's satellites.

A VETERAN watchmaker at Vouvry, Switzerland, claims to have invented a process by which watches will run for years without winding up. A sealed box containing two watches intrusted to the municipal authorities on January 19, 1879, has just been opened, and the watches were found going.

THE Council of the Institute of Civil Engineers have issued their usual lists of subjects for papers in connection with the various premiums which they award. A copy can be obtained at the Institute, 25, Great George Street, Westminster.

M. HANS H. REUSCH describes in the Danish *Naturen* (No. 9, 1881), a new find of Silurian formation on the western coast of Norway, at Ulven, two miles south of Bergen. The fjeld consists here of conglomerate, sandstone, and clay slate, with concretions of limestone which contain remains of Silurian corals, casts of graptolites, and trilobites. The formation is equivalent to that of Central Norway.

SEVERAL further experiments have taken place at the Paris Opera in electric lighting. The success has been very great for the incandescent light in the hall, and for the Brush system on the staircase. For the first time gas has been wholly suppressed in several parts of the house.

IN the *Times* of October 29 is a very interesting account of the present condition of the St. Gothard Tunnel, from a correspondent who went through it.

IN *Bulletin* vol. vi. No. 2 of the United States Geological and Geographical Survey, Mr. S. H. Scudder gives an analysis of the insect remains found in the rich Tertiary Lake Basin at Florissart, Colorado, in anticipation of his forthcoming memoir on the subject.

MR. LATIMER CLARK has printed, in the form of a pamphlet a list of the rare and curious books relating to Electricity and Magnetism which he exhibits at the Paris Exhibition.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. G. Aldridge; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. Francis B. Norcliffe; a Tarantula Spider (*Mygale*, sp. inc.), a Millipede (*Julus*, sp. inc.) from Pernambuco, presented by Mr. Charles C. Craven; a Smooth-headed Capuchin (*Cebus monachus* ♂) from South America, a Richardson's Skua (*Stercorarius crepidatus*), British, four Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, deposited; a Hooded Crow (*Corvus cornix*), a Common Rook (*Corvus frugilegus*), two Grey Plovers (*Squatarola helvetica*), a Ruff (*Machetes pugnax*), a Bar-tailed Godwit (*Limosa lapponica*), British, a Green-cheeked Amazon (*Chrysotis viridigenalis*) from Columbia, a Finsch's Amazon (*Chrysotis finschi*) from Mexico, purchased; four —— Finches (*Coryphospingus cristatus* ♂ ♂ ♀ ♀) from Bolivia, on approval.

OUR ASTRONOMICAL COLUMN

THE BINARY STAR γ VIRGINIS.—Dr. Doberck has recently determined the elements of this star from all the measures available up to the spring of the present year. He gives two orbits, the second of which represents the measures about the periastron-passage somewhat better than the first, but otherwise has no material advantage over it. Dr. Doberck points out that the part of the orbit most interesting to examine was described between the years 1839 and 1847, when the angle of position, after being very oblique, passed quickly through zero, without very much alteration of distance. He finds that the correction required by the angles observed by Dawes, who used a prism for the purpose of keeping the images of the stars apparently in the great circle passing through the zenith, did not much change; those of M. Otto Struve altered in a most pronounced manner; but he adds, "it is quite natural that the errors should be rather large in the case of these stars, which for most observers were at no great distance from the southern horizon, and which, in most telescopes, appear as large disks, at least when the state of the atmosphere is not exceptionally favourable." Dr. Doberck gives a separate comparison with the observations of the Pulkowa astronomer from 1840 to 1874 both as uncorrected and with the corrections in the "Observations de Poulkowa," vol. ix.; he finds that "the observed distances are improved by the corrections, except before 1843, when no corrections ought to be applied," and this is apparent from his investigations on the elements of other double-stars: the angles also are confirmatory, but would be better without the corrections as late as 1853. We subjoin Dr. Doberck's second orbit, and for the sake of comparison the orbit deduced by Thiele, after a very full discussion of the measures up to the year 1865, taken from his treatise published at Copenhagen in 1866.

	Doberck.	Thiele.
Periastron passage	1836·450	1836·685
Node	46° 0′	35° 35′
Periastron from node on orbit (λ)	273 55	283 44
Inclination	33 9	35 6
Eccentricity	0·89040	0·89575
Semi-axis major	3″·94	3″·97
Period of revolution	179·65 years	185·01 years.

We have added 180° to Dr. Doberck's element (λ), to accord with the angle as it was expressed by Dawes and most other observers until within a recent period, but there appears to be slight variation in the brightness of one of the components, as will be seen from an inspection of M. Otto Struve's observations in the Pulkowa volume referred to above.

THE TRANSIT OF MERCURY, NOVEMBER 8.—This is a phenomenon of which we must look for particulars from observers in Australia: it will be wholly invisible in Europe, the conjunction in R.A. taking place at 0h. 38m. a.m. Greenwich time. At the next transit on the morning of May 10, 1891, the egress only will be observable at Greenwich, the sun rising at 4h. 19m., and the last external contact occurring at 4h. 50m. The conditions are reversed in the following transit on November 10, 1894; the first external contact will take place at 3h. 55m. p.m., and the sun's upper limb will be in the horizon at 4h. 18m. This will be the last transit of Mercury in the present century.

COMET 1881 *f* (DENNING).—M. Schulhof of Paris has found elliptical elements for this comet: the period assigned is 7¾ years, but is yet uncertain. A near approach to the orbit of the planet Jupiter is shown by M. Schulhof's ellipse in heliocentric longitude 219°·7, at which point the distance is only 0·18 of the earth's mean distance from the sun.

GEOGRAPHICAL NOTES

MR. JAMES JACKSON, "Archiviste-Bibliothécaire" of the Paris Geographical Society, has published, in a volume of 340 pages, a "Liste Provisoire de Bibliographies Géographiques Spéciales." The list was undertaken at the instance of the Society, and was printed in some haste, we believe, for the recent Venice Congress. But when we remember that the list is only a bibliographical one, a list of lists, in fact, the accumulation of geographical literature is almost appalling. It bears evidence of extensive and careful research, though the author admits that it is by no means exhaustive. Mr. Jackson recently visited the United States to search the libraries there, and the result is a work invaluable to all students of geography. He has wisely devoted comparatively small space to Europe, because, as he states, the works relating to the countries of that continent are well known and easily accessible. Mr. Jackson gives not only bibliographies proper, but references to works on travel and geography, and to periodicals, journals, and transactions, which contain special lists. The divisions of the list are:—Europe, Asia, Africa, America, Oceania, Polar regions, Oceans and Hydrography, Peoples and Nations, Voyages, Travellers, and Geographers, and Generalities. By means of the arrangement under each division the methodical table of contents, the index to authors and periodical publications, the work is rendered easily consultable. It reflects the greatest credit on Mr. Jackson's industry, and on the enterprise of the Paris Society.

THE only new paper in the Geographical Society's *Proceedings* is Mr. William Beardall's on his exploration of the Rufiji River under the orders of the Sultan of Zanzibar, which lasted from December 8, 1880, till February 19, 1881, and, we believe, was undertaken mainly at the suggestion of Sir John Kirk. A sketch map of the river accompanies the paper, on which the portion above Mpembeno, almost to E. long. 37°, is given from Mr. Beardall's surveys. The geographical notes furnish some particulars respecting the Italian Antarctic Expedition, Mr. Joseph Thomson's recent exploration of the Rovuma district of East Africa, and the American Missionary Expedition to the Bihé plateau in West Africa. There are obituary notices of the Visconde Duprat, the Rev. F. W. Holland, Major S. Anderson, R.E., Sir Vincent Eyre, and Col. T. G. Glover, all of whom had rendered more or less important services to geography.

WRITING on a new map of the Dutch East Indies, about to be published at the Hague, the *Annales de l'extrême Orient* for October mentions that, besides its scientific value, this map is interesting from the adventures which have attended its production. The four stones which together form the lithograph were engraved for the most part in Java, the orography and the names alone remaining to be done in Europe. They were carefully packed and despatched to Holland by one of the Dutch mail steamers, but the latter unfortunately was wrecked, and the stones sank to the bottom of the sea. After much trouble the huge cases containing them were raised, and ultimately arrived at their destination. The new map is on a scale of 1 to 500,000, and is in three colours: the mountains in bistre, the seas, lakes, &c., blue, and the remainder in black. The leaves measure 218 centimetres by 78.

IN an "occasional note" on Monday, the *Pall Mall Gazette* predicts a miscellaneous Arctic meeting for the opening of the Geographical Society's session on November 14. If this should prove correct, it is to be hoped that Capt. Gray may be induced to give some verbal information on his discovery that the Polar-pack was this summer six degrees nearer the shores of Europe than in 1879. Though the note in question is, no doubt, to some extent inspired, we believe the evening's programme is by no means finally decided upon. The subject on which the president, Lord Aberdare, in his address would most naturally dilate, would be his recent visit to Venice, in which case we may hope for an intelligent and intelligible account of the proceedings of the Geographical Congress. Hitherto we have heard of little but some effusive speeches and the showering of diplomas and medals on the foreign societies and individuals who took the trouble to send articles to the Exhibition.

WITH reference to the report that Mr. Gordon-Bennett is about to visit Dundee in order to purchase a whaler to be sent in search of the *Jeannette*, it is probable that this new expedition is the one which Lieut. Hovgaard, of the *Vega*, has volunteered to lead.

CAPT. MEYER, of the German schooner *Phœnix*, at Callao, from San José de Guatemala, reports having discovered a new island. According to advices received by the West India Mail it is in lat. 7° 48′ S., long. 83° 48′ W., lying about 188 miles from Punta Aguja, which is the nearest land. The island appeared of volcanic origin, not being over fifty feet above the sea in its highest part. It is a mile long, and about the same width, and Her Majesty's ship *Kingfisher* and the United States vessel *Alaska* have been despatched to examine it. The Chilian transport *Chile* has also been ordered to pay it a visit during a trip she is now making to the North.

MR. JOSEPH THOMSON has returned to Zanzibar from a three months' exploration of the Loende tributary of the Rovuma

River. Not a trace of coal was found along the whole course of the river, though it was reported by the natives to be seen in abundance protruding on the river banks. The whole country is thickly covered with wood. Mr. Thomson contemplates setting out on his second expedition during the present month. He intends to visit the little-known region between the sea and Mount Kilimanjaro, extending from Melinda on the north to Pangani on the south. Mr. Thomson hopes to make important discoveries in geology and botany.

A PRETTY full account of the proceedings of the recent International Geographical Congress at Venice will be found in the new *Bollettino* (for August) of the Italian Geographical Society, which reports in full the papers on the question of oscillations on the coast of Italy. It contains besides a map showing the various arcs of meridian and parallels that have been measured all over the world, and a map of Europe showing the present state of the various trigonometrical surveys in that continent. Russia, Turkey, and Greece are almost blank, and the Scandinavian peninsula is far behind; the other countries are shown covered with triangles.

LUNAR DISTURBANCE OF GRAVITY[1]

IN November, 1878, Sir William Thomson suggested to Mr. G. H. Darwin that he should investigate, experimentally, the lunar disturbance of gravity and the question of the tidal yielding of the solid earth. This Committee of the British Association was subsequently reappointed, and the authors' names were added to the list of its members. In May, 1879, the authors visited Sir William Thomson at Glasgow, and there saw an instrument which, although roughly put together, he believed to contain the principle by which success might perhaps be attained. The instrument was erected in the physical laboratory of the University of Glasgow. The following are the rough details:—

A solid lead cylinder, weighing perhaps a pound or two, was suspended by a fine brass wire, about five feet in length, from the centre of the lintel or cross-beam of the solid stone gallows which is erected there for the purpose of pendulum experiments. A spike projected a little way out of the bottom of the cylindrical weight; a single silk fibre, several inches in length, was cemented to this spike, and the other end of the fibre was cemented to the edge of an ordinary galvanometer-mirror. A second silk fibre, of equal length, was cemented to the edge of the mirror, at a point near to the attachment of the former fibre. The other end of this second fibre was then attached to a support, which was connected with the base of the stone gallows. The support was so placed that it stood very near to the spike at the bottom of the pendulum, and the mirror thus hung by the bifilar suspension of two silks, which stood exceedingly near to one another in their upper parts.

It is obvious that a small displacement of the pendulum, in a direction perpendicular to the two silks, will cause the mirror to turn about a vertical axis.

A lamp and slit were arranged, as in a galvanometer, for exhibiting the movement of the mirror by means of the beam of light reflected from the mirror. It was found to be in incessant movement, of so irregular a character that it was hardly possible to localise the mean position of the spot of light on the screen, within five or six inches. On returning to the instrument after several hours, the observer frequently found that the light had wandered to quite a different part of the room, and it was sometimes necessary to search through nearly a semicircle before finding it again. The cause of this extreme irregularity of the movement of the pendulum was obscure; and as Sir William Thomson was of opinion that the instrument was well worthy of careful study, the authors determined to undertake a series of experiments at the Cavendish Laboratory at Cambridge.

Accordingly throughout 1880 they proceeded to make experiments with an instrument which involved the principle above explained. Several modifications of some importance were introduced. The pendulum was hung in fluid, in order to quickly destroy the oscillations generated by local tremors, and, being suspended by two wires, it was only free to oscillate in one direction, namely, the meridian. There was also introduced an apparatus, which we have not space to explain, by which a known very small horizontal thrust might be applied to the pendulum. By means of this the actual displacements of the pendulum were determinable from the observed displacements of the spot of light on the screen.

The image on the screen was found to be in a state of continual agitation of an irregular character, so that it was not possible to take a reading with very great accuracy. But as the pendulum was hung in fluid, the agitation was not nearly so great as it had been in the instrument at Glasgow.

The observers also found that the pendulum was subject to a diurnal oscillation, and that it stood furthest north towards 6 p.m., and furthest south towards 6 a.m. Superposed on this motion was a gradual change of the mean diurnal position, for during two months the pendulum moved northwards.

The instrument was found to exhibit the flexure of the stone piers of the gallows, even when the force employed was only a slight pressure with one finger. Water poured on the ground round the basement of the stone gallows tilted the whole structure over, and very small changes of temperature in the stone piers were found to give distinct effects. It was concluded that 1 foot of displacement in the spot of light on the scale corresponded with 1″ of change in the direction of the plumb-line with reference to the base of the gallows.

From these experiments the authors concluded that the instrument was susceptible of all the delicacy requisite, but that the mode of suspension was unsatisfactory.

Accordingly in 1881 they proceeded to erect a new instrument in which the support for the pendulum was a copper tube, which itself formed the envelope for containing the fluid in which the pendulum was suspended. The whole apparatus was immersed in a large mass of water, and the observations were taken from outside of the room by means of a telescope. The unsteadiness of the image was diminished, probably on account of the precautions taken against inequalities of temperature in various parts of the instrument, and because the pendulum was hung in a very confined space. The accuracy with which readings could be taken was thus increased.

Similar diurnal oscillations of the pendulum were again observed, and a similar slow change in the mean diurnal position. The authors therefore concluded that these changes are a real phenomenon, and do not depend upon changes of temperature in the instrument itself.

They also noted that there are periods lasting for several days in which the pendulum is in a state of continual agitation, so that the readings taken at a few seconds apart do not agree *inter se*, and that there are other periods of abnormal quiescence. These periods do not seem intimately connected with the external meteorological conditions, at least as far as the experiments have been hitherto carried.

The pendulum was found to be practically insensible to the effect of local tremors, such as are produced by hitting the stone support or stamping on the ground in the immediate neighbourhood of the instrument. But it was extraordinarily sensitive to steady forces. If a force be applied at a point on the floor a dimple is produced in consequence of the elastic yielding of the soil, and any object on the floor is slightly tilted towards the point where the force is applied. Now when a person stood in the room at sixteen feet away from the instrument, and again at seventeen feet, the difference was rendered distinctly evident between the amounts of inclination towards the point of pressure of the stone basement supporting the pendulum in the two cases.

Although no great pains had been taken to render the instrument as sensitive as possible, it was found that an alteration of the plumb-line through 1-100th of a second of arc was distinctly measurable.

The second part of the paper contains an account of the work of some of the previous observers on the same subject.

M. Zöllner's instrument, the "horizontal pendulum," is described. It does not appear that any extensive series of observations have been made with it.

An account of M. d'Abbadie's work is next given. He made his observations by means of reflections from a pool of mercury, and the site of his experiments was at Abbadia, near Hendaye, in the south of France. He found that there were periods of agitation and of quiescence in the mercury, apparently without reference to any perceptible external causes. There were also gradual changes of level extending over several months, and the

[1] Report of the Committee, consisting of Mr. G. H. Darwin, Prof. Sir William Thomson, Prof. Tait, Prof. Grant, Dr. Siemens, Prof. Purser, Prof. G. Forbes, and Mr. Horace Darwin, appointed for the Measurement of the Lunar Disturbance of Gravity. Account of experiments by G. H. Darwin and H. Darwin, read at the British Association, York, September 1881.

experience of several years showed that there was something like an annual inequality of level. There were sometimes changes through 2″ or 3″ which took place in a few hours.

At Geneva M. Plantamour has been making observations concerning variations of the plumb-line, by means of delicate levels, and has arrived at results in general accordance with those of M. d'Abbadie.

The experiments of the authors present a general confirmation of these conclusions, and show that the earth's surface is in a state of continual movement.

With reference to this continual oscillation the authors adduce an experiment which was commenced about three and a half years ago by Mr. Horace Darwin at Down, in Kent. The experiment was undertaken in connection with Mr. Darwin's investigation of the geological activity of earthworms. There are two stout metal rods, one of iron and the other of copper. The ends were sharpened, and they were hammered down vertically about eight feet deep into the soil, and they are in contact with one another, or nearly so. The ends were then cut off about three inches above the ground.

A stone was obtained like a small grindstone, with a circular hole in the middle. This stone was laid on the ground with the two metal rods appearing through the hole. An arrangement with a micrometer screw enables the observer to take contact measurements of the position of the upper surface of the stone with regard to the rods. The stone has, on the whole, always continued to fall, but the general descent can only be gathered from observations taken at many months apart, for it is found to be in a state of continual vertical oscillation.

The measurements are so delicate that the raising of the stone produced by one or two cans full of water poured on the ground can easily be perceived. The effect of frost and the wet season combined is strongly marked, for on January 23, 1881, the stone was 4·12 mm. higher than it had been on September 7, 1880. The prolonged drought of the present summer has had a great effect, for between May 8 and June 29 the stone sank through 5·79 mm.

The changes produced in the height of the stone are, of course, entirely due to superficial causes; but the amounts of the oscillations are certainly surprising, and although the basements of astronomical instruments may be very deep, they cannot entirely escape from similar oscillations.

The last part of the paper contains a discussion of the present aspects of the question, and a criticism of the various forms of instrument which have been used hitherto for the detection of small variations in the position of the plumb-line.

The authors suggest that greater precautions should be taken in the protection of the piers of transit instruments from changes of temperature, and in the drainage of the soil round the basements of the piers; they also draw attention to the disturbing effect of the weight of the observer's body. They express a hope that systematic observations of changes of level may be undertaken at a number of observatories by some instrument analogous to that with which they are working. They are still prosecuting their experiments, and they are in hopes of being able to reduce their instrument to a convenient form, so that it may not be difficult to transport or to erect.

In conclusion they state that they have no hope of being able to observe the lunar attraction in the present site of observation, but they think it possible that they may devise a portable instrument which shall be amply sensitive enough for such a purpose, if the bottom of a deep mine should be found to give a sufficiently invariable support for the instrument.

AN ERROR IN THE COMMONLY ACCEPTED THEORY OF CHEMISTRY

AT a public meeting of the University College Chemical and Physical Society Prof. A. W. Williamson, F.R.S., gave an address on "An Error in the Commonly Accepted Theory of Chemistry."

He began by saying that he had been frequently struck by the fact that two theories believed at one time to be conflicting had often been shown by the progress of study to be both true. As an instance in point he took the rival theories, one of which represented molecules as constituted after the pattern of three or four types, while the other viewed them as containing complex groups called radicles

There was at one time opposition between those who made use of atomic weights and those who employed equivalent weights; the most important step that has of late been taken is the introduction of the notion of equivalence into the atomic theory; an inspection of the series HCl, H_2O, H_3N, H_4C showed that the atom of chlorine has a different value to that of oxygen, nitrogen, or carbon; thus ammonia may be viewed as being formed by replacing three atoms of chlorine in three molecules of hydric chloride by one atom of nitrogen. Thus nitrogen was said to be trivalent or a triad, and other elements, such as phosphorus, boron, &c., were found to resemble it in this respect; oxygen was called a dyad, and it was found that sulphur, calcium, &c., might also be classed as divalent; in short every element might be placed in one or other of the groups, monad, dyad, triad, &c. That an element can belong to one only of these groups was the view still held by one distinguished chemist, who, for instance, said that nitrogen was trivalent only, and that in sal-ammoniac it was not pentavalent, but that the body in question was a molecular compound of two chemical compounds, ammonia and hydric chloride.

He (Prof. Williamson) thought this was little else than a return to Berzelius' mode of representing compounds, though it was open to an objection from which the theory of the Swedish chemist was free; for Berzelius said that the force which united the two molecules that made up the compound molecule was identical with that which held together the atoms of the constituent molecules, the force being in each case electrical; whereas Prof. Kekulé assumes the forces in the two cases to differ, the one being molecular, and the other chemical.

Now as long as we knew neither of these forces, he (Prof. Williamson) thought it hazardous to assert that there was a difference between them. A study of the evolution of heat in chemical processes threw some light on the subject; Berthelot and Thomsen had shown that when you placed a number of substances within the influence of one another, that reaction or decomposition took place which could evolve the most heat, and we must take into account not merely the heat given out by what we considered the purely chemical process, but also that due to the passage of the product from one state of aggregation to another—from the liquid to the solid state when a precipitate was formed.

Thus the chemical process was determined by the heat due to the chemical reaction plus that due to change of physical condition; and this indicated an identity between chemical and physical force. We might learn the same lesson from Deville's truly remarkable researches on dissociation or strictly reversible decompositions. Thus calcic carbonate was decomposed by heat into lime and carbonic acid, but no sooner was the temperature sufficiently lowered than the two recombined; so, when water was heated, the molecules were separated and formed steam, but on lowering the temperature they recombined to produce water. Ice, water, and steam had in many respects different properties—differences in specific gravity, specific heat, refractive power, &c., quite analogous to those which were found between different chemical compounds.

We had therefore no grounds for assuming a difference between chemical and physical force; Kekulé's theory that an atom can have one, and only one, atomic value was no longer tenable, for it involved the assumption of molecular compounds. The theory commonly in vogue was that atoms vary in their value within certain narrow limits; that nitrogen, for instance, was either trivalent or pentavalent. It had even been asserted that the combining power of an atom was independent of the nature of the elements with which it combined; in the words of a very distinguished chemist, "No matter what the character of the uniting atoms may be, the combing power of the attracting element is always satisfied by the same number of these atoms." This view appeared to him (Prof. Williamson) to have been due to a habit of mind naturally prevailing in many studies, but which, he thought, we had found reason in our scientific work to abandon—he meant the absolute as opposed to the relative.

Prof. Williamson then went on to say that he knew of no limitation to atomic value; he did not say there were no limitations, but he did know that many elements have atomic values greater than those commonly assumed.

We found that the character of the atoms materially affected the result; thus gold could not combine with more than three atoms of chlorine alone, but it could take up an additional atom of chlorine if supplied with an atom of sodium at the same time. In this way we got the common double chloride of gold and sodium, $NaAuCl_4$, in which the gold is pentavalent.

We were not to consider the sodium as being here combined

with gold as such, it is combined with the whole group $AuCl_4$, a radicle that is doubtless far more chlorous than chlorine itself.

If any were inclined to doubt the truth of this view, they should write the formula $ClNH_4$ under $NaAuCl_4$, when they would perceive that the radicle $AuCl_4$ corresponded to NH_4, ammonium, the basylous properties of which no one doubted nowadays.

In ammonium we have the basylous energies of four hydrogen atoms concentrated by the inert nitrogen, and the result was a powerfully basylous radicle; in $AuCl_4$ we have the chlorous energies of four chlorine atoms giving a powerfully chlorous radicle.

Among other examples of the kind the Professor cited:

$$K_2AsF_7 \text{ with nonovalent atom.}$$

$$\left.\begin{array}{l} K_2PtCl_6 \\ K_2SiF_6 \end{array}\right\} \text{with octovalent atoms.}$$

$$\left.\begin{array}{l} OI(OH)_5 \\ KSbF_6 \end{array}\right\} \text{with heptavalent atoms.}$$

$$\left.\begin{array}{l} K_2FeF_4 \\ K_2MgBr_4 \\ K_2CuCl_4 \end{array}\right\} \text{with hexavalent atoms.}$$

$$KMgCl_3 \text{ with tetravalent atoms.}$$

And he concluded his address by drawing attention to the conditions that affect the atomic value of an element, which he said were, firstly, the nature of the combining atoms: there was a limit to the number of atoms of one kind that can combine with a given element, but if the element combined at the same time with one or more atoms of a different character, this limit might be passed; and secondly, the temperature, a sufficient rise of temperature being always accompanied by a diminution of atomic value. He thought it of great importance that these points should be considered by those who had artificially limited their horizon. The properties of many of the atoms in complex substances having been in great measure concealed from view by the practice of giving specific names, such as the word "molecular," he thought it would be much better to say at once that we are ignorant of the constitution of these bodies than to resort to such names.

JURASSIC BIRDS AND THEIR ALLIES [1]

ABOUT twenty years ago two fossil animals of great interest were found in the lithographic slates of Bavaria. One was the skeleton of *Archæopteryx*, now in the British Museum, and the other was the *Compsognathus* preserved in the Royal Museum at Munich. A single feather, to which the name *Archæopteryx* was first applied by Von Meyer, had previously been discovered at the same locality. More recently another skeleton has been brought to light in the same beds, and is now in the Museum of Berlin. These three specimens of *Archæopteryx* are the only remains of this genus known, while of *Compsognathus* the original skeleton is, up to the present time, the only representative.

When these two animals were first discovered they were both considered to be reptiles by Wagner, who described *Compsognathus*, and this view has been held by various authors down to the present time. The best authorities, however, now agree with Owen that *Archæopteryx* is a bird, and that *Compsognathus*, as Gegenbaur and Huxley have shown, is a Dinosaurian reptile.

Having been engaged for several years in the investigation of American Mesozoic birds, it became important for me to study the European forms, and I have recently examined with some care the three known specimens of *Archæopteryx*. I have also studied in the Continental museums various fossil reptiles, including *Compsognathus*, which promised to throw light on the early forms of birds.

During my investigation of *Archæopteryx* I observed several characters of importance not previously determined, and I have thought it might be appropriate to present them here. The more important of these characters are as follows:—

1. The presence of true teeth, in position, in the skull.
2. Vertebræ biconcave.
3. A well-ossified broad sternum.
4. Three digits only in the manus, all with claws.
5. Pelvic bones separate.
6. The distal end of fibula in front of tibia.
7. Metatarsals separate, or imperfectly united.

These characters, taken in connection with the free metacarpals and long tail, previously described, show clearly that we have in *Archæopteryx* a most remarkable form, which, if a bird, as I believe, is certainly the most reptilian of birds.

If now we examine these various characters in detail, their importance will be apparent.

The teeth actually in position in the skull appear to be in the the premaxillary, as they are below or in front of the nasal aperture. The form of the teeth, both crown and root, is very similar to the teeth of *Hesperornis*. The fact that some teeth are scattered about near the jaw would suggest that they were implanted in a groove. No teeth are known from the lower jaw, but they were probably present.

The presacral vertebræ are all, or nearly all, biconcave, resembling those of *Ichthyornis* in general form, but without the large lateral foramina. There appear to be twenty-one presacral vertebræ, and the same, or nearly the same, number of caudals. The sacral vertebræ are fewer in number than in any known bird, those united together not exceeding five, and probably less.

The scapular arch strongly resembles that of modern birds. The articulation of the scapula and caracoid, and the latter with the sternum is characteristic; and the furculum is distinctly avian. The sternum is a single broad plate, well ossified. It probably supported a keel, but this is not exposed in the known specimens.

In the wing itself the main interest centres in the manus and its free metacarpals. In form and position these three bones are just what may be seen in some young birds of to-day. This is an important point, as it has been claimed that the hand of *Archæopteryx* is not at all avian, but reptilian. The bones of the reptile are indeed there, but they have already received the stamp of the bird.

One of the most interesting points determined during my investigation of *Archæopteryx* was the separate condition of the pelvic bones. In all other known adult birds, recent and extinct, the three pelvic elements—ilium, ischium, and pubis, are firmly anchylosed. In young birds these bones are separate, and in all known Dinosaurian reptiles they are also distinct.

In birds the fibula is usually incomplete below, but it may be co-ossified with the side of the tibia. In the typical Dinosaurs, *Iguanodon*, for example, the fibula at its distal end stands in front of the tibia, and this is exactly its position in *Archæopteryx*, an interesting point not before seen in birds.

The metatarsal bones of *Archæopteryx* show, on the outer face at least, deep grooves between the three elements, which imply that the latter are distinct, or unite late together. The free metacarpal and separate pelvic bones would also suggest distinct metatarsals, although they naturally would be placed closely together, so as to appear connate.

Among other points of interest in *Archæopteryx* may be mentioned the brain-cast, which shows that the brain, although comparatively small, was like that of a bird, and not that of a Dinosaurian reptile. It resembles in form the brain-cast of *Laopteryx*, an American Jurassic bird, which I have recently described. The brain of both these birds appears to have been of a somewhat higher grade than that of *Hesperornis*, but this may have been due to the fact that the latter was an aquatic form, while the Jurassic species were land birds.

As the *Dinosauria* are now generally considered the nearest allies to birds, it was interesting to find in those investigated many points of resemblance to the latter class. *Compsognathus*, for example, shows in its extremities a striking similarity to *Archæopteryx*. The three clawed digits of the manus correspond closely with those of that genus; although the bones are of different proportions. The hind feet also have essentially the same structure in both. The vertebræ, however, and the pelvic bones of *Compsognathus* differ materially from those of *Archæopteryx*, and the two forms are in reality widely separated. While examining the *Compsognathus* skeleton, I detected in the abdominal cavity the remains of a small reptile which had not been previously observed. The size and position of this inclosed skeleton would imply that it was a fœtus; but it may possibly have been the young of the same species, or an allied form, that had been swallowed. No similar instance is known among the Dinosaurs.

A point of resemblance of some importance between birds and Dinosurs is the clavicle. All birds have those bones, but they have been considered wanting in Dinosaurs. Two speci-

[1] Read by Prof. O. C. Marsh before Section D, British Association, at York, September 2, 1881. Communicated by the Author.

mens of *Iguanodon* in the British Museum, however, show that these elements of the pectoral arch were present in that genus. Some other *Dinosauria* possess clavicles, but in several families of this sub-class, as I regard it, they appear to be wanting.

The nearest approach to birds now known would seem to be in the very small Dinosaurs from the American Jurassic. In some of these the separate bones of the skeleton cannot be distinguished with certainty from those of Jurassic birds, if the skull is wanting, and even in this part the resemblance is striking. Some of these diminutive Dinosaurs were perhaps arboreal in habit, and the difference between them and the birds that lived with them may have been at first mainly one of feathers, as I have shown in my Memoir on the *Odontornithes*, published during the past year.

It is an interesting fact that all the Jurassic birds known, both from Europe and America, are land birds, while all from the Cretaceous are aquatic forms. The four oldest known birds, moreover, differ more widely from each other than do any two recent birds. These facts show that we may hope for most important discoveries in the future, especially from the Triassic, which has as yet furnished no authentic trace of birds. For the primitive forms of this class we must evidently look to the Palæozoic.

SCIENTIFIC SERIALS

Journal of the Asiatic Society of Bengal, vol. l. part 2, No. 2 1881 (July 30), contains:—H. F. Blanford, F.R.S., on the relations of cloud and rainfall to temperature in India, and on the opposite variations of density in the higher and lower atmospheric strata, and description of a rain-gauge with evaporimeter for remote and secluded stations (plate 15).—J. Wood-Mason, on some insects belonging to the Rhopalocera from India and Burmah.—W. T. Blanford, F.R.S., on the Voles (Arvicola) of the Tibet Himalayas and Afghanistan (plates 1 and 2); and on *Myospalax fuscicapillus*, Blyth.

Gegenbaur's morphologisches Jahrbuch, vol. vii., part 2, 1881, contains—R. S. Bergh, on the organisation of the cilio-flagellate Infusoria; a phylogenetic study; plates 12–16. Contains diagnoses of the genera Ceratium, Dinophysis, Protoperidinium (nov. gen.), Peridinium, Protoceratium (nov. gen.), Diplosalis (nov. gen.), Glenodinium, Gymnodinium, Polykrikus, and Protocentrum, with descriptions of several species in each.—Dr. W. Pfitzner, on the minute structure of cell-nuclei.—Prof. Bischoff, on the third or lowermost frontal gyrus (Stirnwindung), and the inner upper lobulus-parietalis gyrus in the gorilla.

Zeitschrift für wissenschaftliche Zoologie, August, 1881 (vol. xxxvi. part 1), contains; Dr. H. Simroth, on locomotion and the organ of locomotion in *Cyclostoma elegans* and other indigenous land and freshwater mollusca (plate 1 and many woodcuts).—Dr. P. Stöhr, on the development of the skull in the Anura (plates 2 and 3).—Dr. A. Gruber, on division in the monothalamous rhizopods (plates 4 and 5).—F. Blockmann, on the development of *Neritina fluviatilis* (plates 6, 7, and 8).—Prof. W. Krause, on the human allantois (plate 9).

SOCIETIES AND ACADEMIES

Manchester

Literary and Philosophical Society, October 4, 1881.—J. P. Joule, F.R.S., &c., in the chair.—On drops floating on the surface of water, by Prof. Osborne Reynolds, F.R.S. It is well known that under certain circumstances drops of water may be seen floating on the surface for some seconds before they disappear. Sometimes during a shower of rain these drops are seen on the surface of a pond, they are also often seen at the bows of a boat when travelling sufficiently fast to throw up a spray. Attempts have been made to explain this phenomenon, but I am not aware of any experiments to determine the circumstances under which these drops are suspended. Having been deeply engaged in the experimental study of the phenomena of the surface-tension of water and the effect of the scum formed by oil or other substances, it occurred to me that the comparative rarity of these floating drops would be explained if it could be shown that they required a pure surface, a surface free from scum of any kind. For, owing to the high surface-tension of pure water, its surface is rarely free from scum. The surface of stagnant water is practically never free except when the scum is driven off by wind. But almost any disturbance in the water, such as the motion of a point of a stick round and round in the water, or water splashed on the surface, will serve to drive back the scum for a certain distance. This may be shown by scattering some flowers of sulphur on the surface. This powder is insoluble and produces no scum, and hence it serves admirably to show the motion of the surface and whatever scum there may be upon it. If when the surface is so dusted a splash be made by a stick so as to throw drops on to the sulphured surface, at the first splash no floating drops are produced; but after two or three splashes in rapid succession it will be seen that the sulphured scum has been driven back by the falling water, leaving a patch of clear surface, and on this drops will float in large numbers and of all sizes. These drops are entirely confined to that portion of the surface which is clear. The drops, either by their initial motion or by the current of air, glide rapidly over the surface from the point at which they are formed. When, however, they reach the edge of the scum they disappear, apparently somewhat gradually. I have this summer made the experiment on several ponds and on various days, and I have never found any difference. Any scum, however transparent, prevented the drops, and they always floated in large numbers when the scum was driven back in the manner described, by the wind or any other way. This result points to the conclusion that whatever may be the cause of this suspension, it depends only on the surface of the water being pure, and not at all on the temperature or condition of the air.—On the mean intensity of light that has passed through absorbing media, by James Bottomley, D.Sc., F.C.S.—Note on the colour relations of nickel, cobalt, and copper, by James Bottomley, D.Sc., F.C.S.

Vienna

Imperial Academy of Sciences, October 13.—V. Burg in the chair.—The following papers were read:—A. v. Liebenberg, experiments on the part of lime in germination.—E. Weiss, computation of the elements and ephemeris of Barnard's comet. —E. Brücke, on some consequences of the Young-Helmholtz theory.—T. W. Brühl, on the connection between the optic and thermic properties of liquid organic bodies.

Paris

Academy of Sciences, October 17.—M. Wurtz in the chair. —The Secretary presented the instructions formulated by the International Conference for Observation of the Transit of Venus. —Crystalline sulphurated copper (*cupréine*), formed at expense of old coins, apart from thermal springs, at Flines-les-Roches, Departement du Nord, by M. Daubrée.—Observations of the comet *b* 1881 (Tebbutt-Gould-Cruls) at Paris Observatory, by M. Bigourdan.—On a remarkable configuration of circles in space, by M. Stephanos.—On Fuchsian functions, by M. Poincaré. —On an experimental peculiarity relative to the equipotential law of Nobili's rings, by M. Guébhard. He has studied, under strong light, the trajectories of minute bubbles between electrodes in badly-conducting liquids; these are quite determinate and independent of gravity, and (friction and agitation of the liquid apart) seem to represent lines of force of the electric flow. With variously formed electrodes he has repeated Antolik's and Mach's experiments made with static discharge; and profiting by certain effects of polarisation, and counter-currents arising on quick reversal of the principal current, has obtained a fixed trace of the lines of flow.—Theory of a rapid vessel, by M. Pictet.—On the currents generated by atmospheric electricity and earth-currents, by M. Landerer. At Tortosa he stretched a wire between the roofs of two houses in a direction making a small angle with the magnetic meridian, and connected it with the water-pipes. The currents generated are variously due to condensation of aqueous vapour, to lightning-discharges, to action of wind, and to earth-currents. The first two and the fourth affect a telephone in the circuit, but not the third (these, however, as well as the second and fourth, deflect a galvanometer). The earth-currents are distinguished from atmospheric currents by their regularity and continuity during pretty long intervals. Variation of the earth-current is a sign of change of weather.—Action of sulphur on alkaline sulphides in very dilute solution, by M. Filhol. In such action on dilute solutions of monosulphide of sodium a polysulphide is formed, without notable production of hyposulphite, and it seems as though the original monosulphide has subsisted, spite of the dilution. But more probably it is decomposed and reconstituted.—On a new series of bases derived from morphine, by M. Grimaux. —On a new alkaloid of quinquinas, by M. Arnaud. The formula adopted for *cinchonamine* (this new alkaloid) is

$C_{19}H_{24}N_2O$. The author found it, simultaneously with cinchonine, in a very dense dark brown-red bark, of resinous fracture, from Santander; there being 0·8 to 1 per cent. of cinchonine, and 0·2 of the other. It differs from cinchonine in having two atoms more of hydrogen.—On the dissociation of carbamate of ammonium, by MM. Engel and Moitessier.—On the subcutaneous sacs and the lymphatic sinuses of the cephalic region in *Rana temporaria*, L., by M. Jourdain. He modifies the enumeration of sacs by Dugés, and indicates some relations hitherto overlooked. *Inter alia*, the lingual sinuses, forming cavities which communicate with the neighbouring reservoirs only by narrow orifices, form a nearly closed system, and M. Jourdain finds in this an explanation (different from that of Dugés) of the mechanism by which the tongue, become turgid, is protruded.—On a curious case of prefecundation observed in a Spionide, by M. Giard.—Contribution to a study of the Flagellata, by M. Kamsler. He has observed in *Cryptomonas ovata*, Ehrbg., transverse striation of the two flagellums serving for locomotion; also a group of long fine flagellums (hitherto unknown), which are also striated and serve for prehension of food; four layers in the body-wall, the outer one colourless, the others having chlorophyll (their structure is described): a spacious stomach with a sort of vestibule (but no œsophagean tube), intestine, and anus; small organisms therein, proving that Cryptomonas does not live on liquid food alone; a pore through which the contractile vesicle communicates with the exterior; an organ which is pro a ly a male apparatus, &c. He also describes the oculiform point in *Phacus pleuronectes*, Dugard, which organ he developed by cultivation in intense light. He considers the structure to prove its visual function beyond a doubt.—On the cause of immunity of adults of the bovine species towards symptomatic or bacterian charbon in localities where this malady is prevalent, by MM. Arloing, Cornevin, and Thomas. Most of the young animals in an infected district are spontaneously inoculated with various quantities of the virus, and while those receiving much take the disease in fatal form, those receiving little have a mild attack, sufficient to insure future immunity. M. Bouley remarked on the bearing of hereditary influences, and M. Pasteur on the error of supposing that young animals had a greater aptitude to receive contagion.

October 24.—M. Wurtz in the chair.—The following papers were read:—Detonation of acetylene, cyanogen, and endothermal combinations in general, by M. Berthelot. Gases formed with absorption of heat (acetylene, &c.), which do not detonate under simple heating, may be brought to explosion through sudden shock (*e.g.* through fulminate of mercury); this shock acts only on a certain layer of gaseous molecules, communicating enormous kinetic energy; the molecular edifice loses its relative stability and falls to pieces, and the initial energy is instantly increased by that corresponding to heat of decomposition of the gas. Hence a new shock produced on the next layer, which causes the same decomposition, and so on, to total destruction of the system.—On a general determination of the tension and volume of saturated vapours, by M. Clausius.—On an apparatus for determining, without pain to the patient, the position of a projectile of lead or other metal in the human body, by Prof. Bell. This is a modification of Hughes' induction-balance. One flat coil is superposed on another, so that the edge of the former is near the axis of the latter. One has thick wire, and is the primary circuit, the other has thin wire, and is the secondary. The two are dipped in paraffin and fixed in a wooden frame with handle. A vibratory current from a battery traverses the primary coil, and a telephone is put in circuit with the other. When the common part of the two coils comes near a metallic body silence gives place in the telephone to a sound which varies in intensity according to the nature and form of the body. It is found advantageous to insert in the two circuits two other coils similar to the first, but much smaller, and the common surface of which can be altered with a micrometric screw; also to insert an electrostatic capacity in the primary.—On the parasitic nature of disorders arising from impaludism, by M. Leverson. The efficiency of sulphate of quinine as an antidote is thus accounted for (various parasitic elements in the blood are described).—Note on the quality of waters of the Isère as regards the project of an irrigation-canal from the Rhone. Owing to the presence of salts of soda and magnesia in considerable quantity, the water of the Isère is absolutely unfit for irrigation.—On a configuration of fifteen circles, and on the linear congruences of circles in space, by M. Stephanos.—On the mathematical theory of the vibratory movement of bells, by M. Mathieu.—On the electrolysis of water, by M. Tommasi. A zinc-copper or zinc-carbon element, immersed in dilute sulphuric acid, does not decompose water, conformably to theory, if the two electrodes are of platinum. For this decomposition to take place, the positive electrode must be formed of a metal which, under influence of the voltaic current, can combine with the oxygen of the water.—On a proportion-compass (*boussole de proportion*) for measurement of resistances, by M. Carpentier. Suppose on the surface of a sphere, the vertical diameter of which is taken as polar axis, two similar circuits along two meridians at right angles to each other. Currents along these circuits affect a small magnetic needle hung at the centre of the sphere, which needle sets in the direction of the resultant of the two forces. This depends on the ratio of the intensities, and this ratio of the strength of one component to that of the other is precisely measured by the trigonometric tangent of the angle formed by the resultant with the other component. For measurement of resistances a current is made to divide between the circuits, and of course does so equally. Then the resistance to be measured is added to one circuit, and the current then divides inversely as the resistances. Two ways are indicated of eliminating the influence of terrestrial magnetism.—On the variation of the annual number of thunderstorms at Rio de Janeiro, by M. Cruls. In the period 1851–1876 (during which the annual number of thunderstorms is found to vary between eleven and forty-nine), he makes out a close correspondence between the curve of storms and that of solar spots. A curve for Toronto shows the same thing, though less distinctly. M. Faye expressed a feeling of reserve as to this correspondence. The period of spots could be reproduced in that of thunderstorms only if the spots sensibly affected the heat sent us by the sun; but no trace of an eleven-years' period has been found in annual temperatures. The conclusion is that solar spots and our thunderstorms are not in the relation of cause and effect. The correspondence indicated by M. Cruls is not sufficient to prove the necessity of finding a connection between the two phenomena.—On a new hydrate of carbon, by M. Morelle. He calls it *bergenite* instead of *bergenin*, the name given (1850) by its discoverer, M. Garreau, who did not study it very fully. It is got from Siberian saxifrage. M. Morelle arrives at the formula $C_{16}(C_4H_4O_4)_5$ (which corresponds to 75·75 per cent. of acetic acid). It is a pentatomic alcohol, ranking with pinite and quercite.—On the comparative toxicity of different metals, by M. Richet. Instead of injecting, he rendered the medium poisonous (*e.g.* the water for a fish). He named the *limit of toxicity* the quantity of poison per litre of water, allowing a fish to live more than forty-eight hours. Thus he shows that there is no precise relation between the atomic weight, or the chemical function of a body, and its toxical power.—Researches on the circulatory system of *Spatangus purpureus* by M. Kiehler.

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THURSDAY, NOVEMBER 10, 1881

BALFOUR'S "COMPARATIVE EMBRYOLOGY"

A Treatise on Comparative Embryology. By Francis M. Balfour, LL.D., F.R.S., Fellow and Lecturer of Trinity College, Cambridge. Vol. II. (London: Macmillan and Co., 1881.)

MR. BALFOUR has brought out the second volume of his treatise with admirable punctuality, and zoologists will find it no less valuable than the first. Indeed it is in many ways more attractive than the earlier volume, on account of the fact that the developmental history of the Vertebrata is here dealt with, and has an interest for a large class of anatomists who are not addicted to the study of other organisms. Moreover, in treating of the Vertebrata (or Chordata, as he prefers to call them when the group is so extended as to comprise the Ascidians) Mr. Balfour has introduced a very considerable amount of original matter.

The structure of the Vertebrata is not only more complex than that of other animals, but it is also better known, and has been more minutely discussed by anatomists; and similarly the development of various Vertebrate types has been more keenly scrutinised than that of other forms. Amphioxus, the lamprey, the salmon, the dog-fish, the frog, toad, and newt, the turtle and lizard, the common fowl, the guinea-pig, rabbit, bat, and even man, have formed the subjects of numerous memoirs devoted to one or other of their phases of development. This has been going on for many years, in fact ever since Remak and Kölliker laid the foundations of what may be called "cellular embryology." The chick, the frog, and the rabbit have during this period enjoyed the services of a class of workers difffering from those who have studied other animals. The latter have been naturalists interested in the study of embryology as throwing light on the affinities and origins of animal forms; the former have been distinctively medical men, who have sought in the minute study of the origin of the tissues of man and other Vertebrate animals indications which may be of service towards attaining the great desideratum of modern medicine, viz. a thorough knowledge of the physiology (*i.e.* the working of the mechanism) of man. Accordingly, from an early period the methods of the histological laboratory have been applied to the study of the Vertebrate embryo, and that by a large number of accomplished investigators, whilst it is only quite recently that the naturalists, as distinct from the medical men, have learnt to apply the same methods to the study of all organisms. There is at the present moment a movement from both sides and a fusion of the hitherto separate streams of "zoological" and "medical" embryology, which is marked as an epoch in the history of science by Mr. Balfour's treatise.

The medical histologist and physiologist has learnt that if he would comprehend the process of the cleavage of the egg and formation of the blastoderm and primitive organs he must not confine himself, as hitherto, to the limited area of comparison offered by the chick, the frog, and the rabbit; he must make common cause with the zoologist, and embrace the whole animal series in his view. He will, I cannot doubt, also soon openly acknowledge that the application of elaborate instruments of measurement to the nerves and muscles of dogs, rabbits, and frogs has furnished what knowledge it can in reference to man, and that if physiology is to move out of a barren path the whole evolutional series connected with man—the lowest as well as the highest—must be made the subject of experiment.

On the other side we find the field-naturalist—the lover of the forms and colours of animals—no longer content with a superficial study. To solve the problem which Mr. Darwin has succeeded in placing before him as the aim of his science, it is necessary that the minute structure of all animals—their cellular anatomy and embryology—shall be as accurately known as is that of the rabbit and frog to physiologists. Accordingly it is becoming more and more usual to find naturalists trained in the histological methods originated by the medical physiologists, and pursuing precisely the same inquiries as they do.

Since the germ-layer theory was shown to apply not exclusively to the Vertebrata, but, in a modified form, to the whole animal kingdom, embryology has become one body of doctrine equally significant for the practical ends of the medical man and for the speculative conclusions of the philosopher and naturalist. This fact is abundantly evident from Mr. Balfour's two volumes; in the earlier as in the present the chief aim is to trace the history of the units of structure known as cells from the parent egg-cell until the adult form is attained. The doctrine of cell-structure and that of evolution taken together serve to unite the interests of scattered and sometimes reciprocally contemptuous groups of scientific men—the physiologist and the naturalist will turn each with equal pleasure and profit to Mr. Balfour's treatise.

The embryology of the Chordata is first of all treated of, in the present volume, in zoological order. The terms Cephalochorda (for Amphioxus), Urochorda (for the Tunicata), and Craniata, which were proposed as divisions of Vertebrata in my "Notes on Embryology and Classification," are used, with some modification, by Mr. Balfour. Instead of Craniata the term Vertebrata is used, whilst in place of Vertebrata as formerly applied, the term Chordata is used. This change is open to objection, chiefly on the ground that it is more convenient to retain so well-known a term as Vertebrata for the more important group, and not to sink it in subordination to an unfamiliar term: also, as it seems to me, on the ground that the implication in both words "Chordata" and "Vertebrata," as used by Mr. Balfour, is delusive. All animals with a "chorda" would not necessarily take their place in the group of pharyngo-branchiate Chordata possessed of a tubular nervous axis and myelonic eyes, to which rather than Chordata the old name "Vertebrata" is appropriate—the Tunicates having been assimilated by the old-established group in the course of a natural process of the growth of knowledge.

The defence of the limitation of the term Vertebrata to the Craniate Vertebrates on the ground that they alone possess "vertebræ," raises the whole question of what we are to understand in the widest sense by the words "vertebræ" and "vertebrate." It seems to me to be difficult to construct a definition of either of these words

which will apply to structures present in the Lampreys, Sturgeons, Chimæra, and Dipnoi, and will not apply to structures present in Amphioxus. Gegenbaur's conception of the inapplicability of the term Vertebrata to forms devoid of myotomes as are the Tunicata, is, it seems, more reasonable. But even this objection is removed by the fact that in the tail of some Ascidian larvæ, and in Appendicularia, there are indications of segmentation of the muscular tissue.

However that may be, Mr. Balfour's account of the developmental phenomena exhibited by the various groups is of the greatest value, because it possesses three characteristics which also marked his first volume: it is complete as an epitome of all the very numerous and important contributions to the subject due to the Continental and English embryologists who have written so abundantly of late years; it contains a large amount of the author's original unpublished observations; and, lastly, it is no mere catalogue of the opinions of this and that authority, but is a critical treatise in which without arrogance, but with argumentative skill, a definite view as to the significance of the phenomena described, even when these are obscure and difficult of interpretation, is put before the reader. This latter feature gives Mr. Balfour's writings a special value, as pointing out lines of research for future observers.

The chapter on the Elasmobranchii is chiefly based on the author's original researches, which were published as a monograph. He has been extending his observations to the Cyclostoma and Ganoidei during the period in which he was also engaged in the preparation of the two volumes of the present treatise. Valuable original drawings (Figs. 38, 39, 40, 43, 45, 46 and 48) of sections of embryos of *Petromyzon Planeri* are given, and a correspondingly original account of the developmental history. Similarly the Ganoids, Accipenser, and Lepidosteus are illustrated by original drawings prepared from embryos supplied to Mr. Balfour by Prof. Salensky and Prof. Agassiz. In discussing the Amphibia much use has been made of the excellent figures given by Prof. Götte in his great work on the development of *Bombinator igneus*, but here again Mr. Balfour is able to rely upon original observations upon the newt, carried out in his own laboratory by Messrs. Scott and Osborn.

The fact that Mr. Balfour does not give us in a precise form a history of the development of the common frog from stage to stage, is explained by the special nature of his treatise, which aims at putting forward the generalisations of embryology and dealing with the developmental phenomena of the whole range of animal forms rather than providing the commencing student with a few selected examples of growth from the egg. Much is said about the common frog in the chapter on Amphibia, and from the general statements which it contains, in addition to the statements definitely relating to the frog, a nearly complete answer can be obtained to all questions which suggest themselves in relation to the main features of development in that animal.

The Birds are treated next in order after the chapter on Amphibia, and necessarily the common fowl—on which Mr. Balfour published some years since, in conjunction with Dr. Foster, a separate work designed for the use of junior students—is the source from the study of which his facts are derived. In this chapter, and in that on the Mammals, Mr. Balfour discusses the views of Kölliker as to the origin of the mesoblast from the epiblast of the primitive streak, and other interesting points raised, since his earlier work, by the observations of Braun on parrots and ducks, and of Gasser on geese.

The chapter on Reptilia is remarkably short, owing to the fact that very few observations have been made on members of this class, and that in many important points they agree with birds. Original drawings relating to *Lacerta muralis* and *Chelone midas* illustrate this section.

In dealing with the Mammalia Mr. Balfour has to depend chiefly upon the recent researches of Ed. van Beneden and of Kölliker, and his critical power and fair dealing is shown in the way in which he treats the points of disagreement between those two admirable investigators. The main outlines of our knowledge of the later development of the Mammalian embryo and its fœtal appendages were laid down many years ago by Bischoff and by Kölliker; but Mr. Balfour has given a particularly interesting account of the various modifications of the structure of the placenta presented by different mammals, illustrating his statement with woodcuts from the works of Prof. Huxley and Prof. Turner. With regard to the evolution of the placenta and the phyletic connection of the several forms seen in different recent Mammalia, he has some important original suggestions to offer.

It is impossible to give any idea, in a review such as this, of the abundance of facts and the thoroughness of treatment to be met with in the portion of Mr. Balfour's book which we have just noticed. It deals with the groups of Vertebrata one by one, and with the hundreds of questions which the greater or less knowledge of the particular group so far in the possession of embryologists, brings into existence in endless variety. The general results of such a method of exposition cannot be summarised in a review.

But such summarising has been to a very considerable extent carried out by Mr. Balfour himself in the latter two-thirds of the present volume, which will be found the most readable, and in some respects the most important, part of the whole work. We have a chapter on the comparison of the formation of the germinal layers and of the early stages in the development of Vertebrates, one on the ancestral form of the Chordata, and one treating of the mode of origin and homologies of the germinal layers in animals generally and of larval forms, their nature, origin, and affinities. To these chapters succeed twelve entitled "Organogeny," which actually constitute a treatise on comparative anatomy, based upon embryological data, under the headings (1) epidermis and derivatives; (2) nervous system; (3) organs of vision; (4) auditory organs, olfactory organs, and sense organs of the lateral line; (5) the notochord, the vertebral column, the ribs, and the sternum; (6) the skull; (7) pectoral and pelvic girdles and the skeleton of the limbs; (8) the body cavity, the vascular system, and the vascular glands; (9) the muscular system; (10) excretory organs; (11) generative organs and genital ducts; (12) the alimentary canal and its appendages in the Chordata.

In these chapters many of the facts which have been previously detailed in that part of the work devoted to the treatment of group after group are again brought forward

and looked at from a new point of view in relation to the doctrine of evolution, and facts which did not find their way into the earlier portion of the work receive consideration. Especially in the chapters on organogeny we find the questions connected with the probable first origin and later modifications of the nervous system and of the organs of special sense dealt with so as to supplement the earlier zoological chapters. It is not possible to single out for special notice any one of the discussions which may thus be said to sum up and give the general results of Mr. Balfour's work. But among the more interesting, as dealing with burning questions, are those relating to the origin of the limbs of fishes (based upon the author's recent investigations), and the nature of the excretory organs found in the different groups of the animal kingdom. In reference to the latter point Mr. Balfour commences his discussion with a remark which may be taken as an example of the judicial style in which he handles such problems. He says, "although there is not a little to be said for holding all these organs to be derived from some common prototype, the attempt to establish definite homologies between them is beset with very great difficulties."

The present volume is illustrated by about four hundred woodcuts, and consists of more than six hundred pages of royal octavo size. The first volume was of very nearly the same size, and as copiously illustrated. Together they form a contribution to that science of Biology which our countryman, Charles Darwin, has refounded and reformed, of which English men of science may feel justly proud. No work of the kind exists in any foreign tongue, and probably no such work would have been undertaken had not Mr. Balfour given himself to the task. Translations of Mr. Balfour's book are at this moment in course of publication both in Germany and in France. The thoroughness with which he has carried out the revision and incorporation of a few more than a thousand scattered memoirs by contemporary writers, and the excellence of his critical remarks and original observations and drawings, are all the more remarkable when it is remembered that only three years have passed since the work was commenced, and that during that time Mr. Balfour has been actively engaged in lecturing and teaching in his laboratory at Cambridge, has published several original memoirs himself, and has superintended the production of as many more by his pupils.

The University of Glasgow has recently recognised the importance of Mr. Balfour's labours in embryology by conferring upon him the degree of LL.D. *honoris causâ.*

Cambridge men, and all who hope for the restoration of the English Universities to their legitimate place in the academic sisterhood of Europe, must feel proud of Mr. Balfour and the steadily working school of biologists which has risen around the Trinity Prælector on the banks of the Cam. The Cambridge biologists are now a power in the scientific progress of the country, and it is from Cambridge that the new men come to fill positions as teachers of biological science in the colleges of Manchester, Birmingham, Dublin, Eton, and elsewhere. Few persons, however, know the smallness of the share which the University of Cambridge, as such, has had in this admirable development, and how necessary it is, if the present condition of activity is to continue within its boundaries, that adequate arrangements shall be made in permanence for the maintenance of the laboratories and for the salaries of those who are at present gaining honour for the University without receiving from it any return.

E. Ray Lankester

PRIMITIVE INDUSTRY

Primitive Industry, or, Illustrations of the Handiwork in Stone, Bone, and Clay of the Native Races of the Northern Atlantic Seaboard of America. By Charles C. Abbott, M.D. (Salem, Mass.: George A. Bates, 1881.)

THIS work is a valuable contribution to our knowledge of American archæology. Dr. Abbott describes successively the principal types of stone, bone, and bronze antiquities, especially those of New Jersey. The work is illustrated by more than 400 woodcuts, and is divided into 33 chapters devoted to "Stone Axes; Celts; Chisels and Gouges; Grooved Hammers; Semilunar Knives; Chipped Flint Knives; Drills; Awls or Perforators; Scrapers; Slick Stones and Sinew Dressers; Mortars and Pestles; Pottery; Sheatite Food-Vessels; Pitted Stones; Chipped Flint Implements; Bone Implements; Agricultural Implements; Plummets; Net-sinkers; Spear-points and Arrow-heads; Flint Daggers; Grooved Stone Club-heads; Pipes; Discoidal Stones; Inscribed Stones; Ceremonial Objects; Bird-shaped Stones; Gorgets; Totems; Pendants and Trinkets; Copper Implements; Hand-hammers and Rubbing-stones; Shell Heaps; Flint Chips; Palæolithic Implements; the Antiquity and Origin of the Trenton Gravels."

The number of stone implements which have rewarded Dr. Abbott's industrious search is really surprising. In New Jersey alone he has amassed no less than 20,000 specimens.

"From the great number of stone axes," he says "already gathered, and that remain to be gathered, from the area of the State of New Jersey, it is clear that this form of weapon or implement, as the case may be, was in constant and universal use among the Delaware Indians. In some localities, of several square miles in extent, there have been found from three to five axes in every one hundred acres, and still others are occasionally brought to light by the plough. Allowing but one-half the smaller number to have been left lying in every one hundred acres of the State's area, when abandoned by the Indians, there would remain, for the benefit of archæologists, the enormous number of one hundred and twenty-five thousand stone axes."

Considering the great abundance of stone implements, the rarity of typical scrapers in the United States is an interesting fact. No doubt many of the stone implements were used as scrapers, but I have hardly seen any specimens from Eastern America of the true typical North European and Eskimo form. Some of those figured by Dr. Abbott, though they may have served as scrapers, certainly are not of this type; and although others may be so, for instance that represented by Fig. 107, p. 124, it is difficult to speak positively, because Dr. Abbott does not give sections of the implements, so that in many cases their true form is doubtful. We would suggest to him to supply this omission in subsequent editions of his work.

Perhaps the most characteristic of American types are

the "spades" or "hoes," "oval plates of flint flat on one side and slightly convex on the other, the outline being chipped to a sharp edge." These differ principally from the European implements, which most nearly approach them, in their greater thinness. It is possible that they may have been used for agricultural purposes, and some bear traces of use, such as digging in sandy soil would produce.

Fragments of pottery are very abundant in New Jersey, but "unbroken articles of earthenware are rarely met with."

"A large portion of the pottery made by the Indians, however, was not made from pure clay just as it came from the bed, but the clay-earths that overlie the others were utilised and made available by mixing with them quartz granules and pounded shell. Much of the pure clay, which in many places was accessible, would need far more manipulation than the Indian potters would care to give it, and as the mixture of clay and shell was simpler and would meet all their requirements, it was, very naturally, most frequently used. They nevertheless possessed the knowledge of successfully working in pure clay, as sherds are found so made, and their well-formed clay smoking pipes are a further proof of the fact."

The forms are generally simple, and the ornamentation rude. The patterns are almost, if not quite, invariably geometrical; and generally made either with a pointed stick or bone, with the thumb-nail, with a twisted cord, or by covering the vessel, of course when soft, with coarse cloth.

Copper implements are comparatively rare, and Dr. Abbott is disposed to think that they—

"Were never designed for use as weapons or implements, but were intended for display upon special occasions, as for instance in their various dances, when much ceremony was observed, and various objects were displayed that at other times remained hidden in the custody of their fortunate owners, or of the appointed keepers, if tribal property."

He is clearly of opinion that they were merely hammered into form and never cast. They are always of very simple form.

As already mentioned, in one county of New Jersey alone Dr. Abbott has gathered no less than 20,000 stone implements. No one implement or pattern is peculiar to any one district, though certain forms abound in particular localities.

"Although in no instance has any one pattern of arrow-head been found so characteristic of a given locality as are the argillite fish-spears of the alluvial deposits along the river, it has frequently been observed by collectors that some particular form occurred in considerable numbers in a locality of very limited area, as a field or other small plot of ground. In my own collecting tours I have frequently noticed this, and can recall now certain fields that appeared to have only leaf-shaped arrow-heads, and others where the triangular pattern was alone met with. Even this is noticeable with other forms of chipped implements, and local collectors report fields, or other spots of a few acres, where only scrapers are found. This localising of certain forms has been so frequently noticed that it cannot be considered as a mere chance occurrence, yet it is scarcely susceptible of any rational explanation."

Dr. Abbott is of opinion that the Eskimo occupied New Jersey long before the advent of the Red Indian. To this earlier race he especially ascribes the implements made of argillite, which he regards as much older than the rest. Altogether he has found 4400 implements of this material, 233 being well-made drills or perforators and scrapers, the others spear-points, fishing-spears, arrow-heads, and knife-like implements. They are altogether ruder than the implements of flint and other materials, but

"Although it is true of these implements that they are of more primitive forms, and therefore probably older than the objects made of quartz and jasper, the argument does not rest so much upon this greater simplicity, as upon their decomposed condition, their occurrence at greater depths in the undisturbed soil, the greater adaptability of the spears for fishing purposes, and the absence of all indications in the deeper soils, of the utilisation of the minerals habitually used by the later Indians."

"For these reasons," he continues (p. 463), "it is claimed that we find sufficient evidence in them of a pre-Indian people—believed to be the Eskimo—who, it is further claimed, are the direct descendants of that still older race, the fabricators of the Palæolithic implements of the River Drift."

To many minds the most interesting question raised by Dr. Abbott's work will be the evidence as to the antiquity of man in America. Certainly some of the implements which he has discovered seem to belong to palæolithic types. In some cases he assures us they have been found in association with remains of the mastodon, and he is satisfied that those found in the Trenton gravels must be coeval with the gravels themselves.

The work concludes with a memoir by Prof. Henry Carvill Lewis on the Antiquity and Origin of the Trenton Gravel Beds. Prof. Cook is of opinion that they are of glacial origin, and derived from floods caused by the melting of a great continental ice-sheet. Prof. Lewis, on the contrary, maintains that they are post-glacial—in fact, a true river gravel of comparatively recent age. It cannot, he maintains, be assigned to the glacial epoch, except by assuming that there have been no river gravels deposited since that time, an assumption which he regards as quite untenable. On the whole, he concludes that there is no evidence which would render it necessary to assign to those gravels, or of course to the implements found in them, an antiquity of more than 10,000 years.

SACRED MYTHS OF POLYNESIA

Die heilige Sage der Polynesier—Kosmogonie und Theogonie. Von Adolf Bastian. (Leipzig: Brockhaus, 1881.)

PROF. BASTIAN, on a late journey made to enrich the Ethnological Museum of Berlin, stayed a short time in New Zealand and the Sandwich Islands, and there gathered some interesting information as to native traditions, some not yet published, and some which have been neglected (if ever met with) by European students. The documents now printed in a small volume all strengthen the opinion which has for years been gaining ground among anthropologists as to the civilisation of the Polynesians. It is true that they were found in Capt. Cook's time living in a barbaric state, and their scanty clothing and want of metals led superficial observers even to class them as savages. But their beliefs and customs

show plain traces of descent from ancestors who in some way shared the higher culture of Asiatic nations. At Wellington Prof. Bastian found Mr. John White, who, as a skilled translator of Maori, worked for Sir George Grey in bringing out the "Polynesian Mythology," and has been engaged in the study of native lore ever since. He is about to publish the results of his long study with the aid of the Colonial Government, and we have here as a specimen one of those mystic Maori cosmogonies which make us fancy we are hearing some Buddhist or Gnostic philosopher pour out his dreamy metaphysics about the origin of things. Out of the Primal Night, says the Maori poet, there divided itself Nothing, then came Darkness, then Seeking, and Following, and then such stages as Conception of Thought, Spirit Life, Desire, Coming into Form, Breath of Life, Space. All this is of a piece with the native Polynesian poetry in Taylor's "New Zealand," and that lately published by Judge Fornander in Hawaii. The poem that begins with the time when there was no voice nor sound, no day nor night, may remind us of the famous hymn of the Rig Veda that begins "Nor aught nor naught existed." We find here the well-known chant of Taaroa, how in the emptiness of space, when there was no earth nor sky nor sea, Taaroa passing into new forms became the foundation of the rocks and the sand of the sea, and the land of Hawaii was born as his shell. Prof. Bastian well compares this with the Scandinavian poem in the Edda, how there was no sand nor sea nor salt waves, no earth nor sky above, till Bör's sons made the mighty Midgard—earth. He points out, as he has already done, the curious likeness between the Scandinavian story of the fishing up of the monstrous Midgard-snake, and the South Sea Island tale of Maui fishing up the island of New Zealand. Not less striking is such an analogy as the Polynesian Taaroa mating with his own energy in female form, like a Hindu god with his Sakti. The author may well ask, are these people, with such far echoes of Orphic, Chaldean, Buddhist philosophy, the simple playful children of nature on whom we look down as representing the lowest rungs in the ladder of development? In Hawaii the German anthropologist learnt much from King Kalakaua, who is thoroughly initiated in the religious ideas of his royal predecessors, who used to have the eyes of their enemies offered them by the high priest in the stone bowl which his majesty still keeps as a curiosity. Out of the royal library he produced a MS. temple-chant, written about the beginning of this century, containing a cosmogony, of which Prof. Bastian reproduces as much as he had time to have translated. It has real poetry in it, and as a piece of child-like philosophy it is not without interest in its enumeration of the orders of beings, the grubs and worms, the sea-eggs and mussels, the seaweed in the ocean watched by the grass on land, the cranes and the gulls at sea watched by the hawks on land, and so on with trees and other creatures, till at last the gods come into being, and man rises out of the night. For a specimen of barbaric science may be mentioned the Maori myth told to the author by Mr. Davis, how the Moon arose out of the ocean, and still keeps the traces of this marine origin in its phases, which follow the ebb and flow of the tide.

EDWARD B. TYLOR

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

The Struggle of Parts in the Organism

ALTHOUGH I agree with the Duke of Argyll that the pages of NATURE are not adapted to a discussion on the general question of Theism, the letters which you this week publish leave me no alternative but that of entering upon the subject, so far at least as it seems desirable that I should now express my individual opinion on the points which your correspondents have raised.

My statement of what I conceive to be the position of the matter may best be rendered by answering first the questions which are put to me by Dr. Carpenter. He desires me to explain the "precise sense" which I attach to the phrase, "a general law whose operation is presumably competent to produce any set of phenomena," and proceeds in a most terse and lucid manner to expound the well-known and unquestionable truth that "in the *purely scientific* sense a 'law of nature' is nothing more than a general expression of a certain set of uniformities which the intellect of man discerns in the surrounding universe," &c. This is the only sense in which I have intended to use the term, and if my meaning has been obscured by speaking of a general law "producing" any set of phenomena, it is only because the idea of "a law of nature" as "any kind of *coercive* agency," or indeed anything other than "a generalised expression of facts," was so far from my mind that I perhaps too readily employed a convenient, though metaphorical,[1] mode of expression—just as one speaks of the sun rising, &c. In speaking then of Natural Selection as "competent to produce" certain phenomena I only meant that, given a certain set of activities and conditions supposed to be uniform, and the phenomena in question would occur, whether or not these activities and conditions are taken to be due to a disposing mind. So far, therefore, am I from maintaining "that there is anything in the *law* of Natural Selection that places it in a different category from every other," that my whole contention is exactly the reverse—namely, that the law of natural selection stands to certain observed phenomena of biology in just the same logical relation as, for instance, the law of gravitation stands to certain observed phenomena of astronomy. Indeed, it is just because I hold the laws of evolution to be so precisely identical in logical *status* with all other so-called laws of nature, that I see no better evidence of Design in "the adapted structures" of "the Human Hand" than I do in the adaptation, say, of a river to the bed which it has itself been the means of excavating.[2] In both cases I believe that physical causes have been at work (whether or not there have been metaphysical causes of a mental nature behind them), with the difference only that the one set are more complex and less obvious than the other. But in each case alike, if the physical causes are deemed adequate to furnish a scientific explanation of the effects, there is no residual effect to be carried over for explanation by any metaphysical theory of Design. Design, of course, there may be in both cases; I only maintain that if the laws of evolution are conceded to stand to the structure of an organism in the same logical relation as certain other natural laws stand to the structure of a river's bed, then, *ex hypothesi*, the one set of adaptations constitutes no *evidence* of Design different in kind from that furnished by the other.

This appears to be the point where my opinion has had the misfortune to be found at variance with that of the Duke of Argyll. For in his last letter he says that "there are in nature a few [? many, *vide infra*] cases of apparent adaptations and of

[1] *I.e.* "metaphorical" as investing a natural "law" with the signification of a natural "cause." A law of nature I take to mean a general proposition or formula which expresses the observed operation of certain physical causes, whether or not these are known. Therefore, although it is, strictly speaking, incorrect to say that "natural selection is a law competent to produce adaptations," in using such a form of expression one may be understood to mean "the sundry physical causes, whose joint operation is formulated by the law of natural selection, are competent to produce," &c.

[2] This illustration is borrowed from Mr. Wallace, who, in his "Natural Selection," elaborates it very instructively.

orderly arrangements of a very simple kind which do not necessarily suggest Mental Purpose. They may be the effect of what we call accident, or of the action of elementary laws under no guidance or direction. Inorganic phenomena furnish many examples of such arrangements," &c., the argument proceeding to the conclusion that "the writers of the last generation were perfectly right in resting the general Argument from Design on the separate instances of adaptation in which the mark of Mind is most signal and conspicuous"—*i.e.* in organic structures. Now until it is shown wherein we are justified in classifying natural laws under two such categories as "elementary laws under no guidance or direction," and laws whose "action" gives rise to "separate pieces of evidence pointing to the operations of special design"—until this is shown I must remain of the opinion that "Mr. Darwin's theory of Natural Selection" *does* "touch this argument" of scientific teleology. The distinction between two such sets of general laws is clearly not one that can be recognised by science, and if it is conceded that the theory of Natural Selection is competent to explain the proximate or physical causation of "structural adaptations," we have no more right to refer the latter to ultimate or metaphysical causes than we have so to refer "orderly arrangements of a very simple kind which do not necessarily suggest Mental Purpose." For if this concession is made it means that the one set of causes differs from the other only, as I have said, in being somewhat more complex in character and less obvious in operation.

Again, the Duke of Argyll says he is "not able to accept" the distinction which I drew between scientific and metaphysical teleology. The distinction nevertheless remains, and it seems to me so obvious that I must suppose the Duke has in some way failed to appreciate my meaning. However he says, "The fundamental proposition of all arguments from Design is simply this: that the exquisite adaptations to special ends which are conspicuous in organic nature are, and can only be, the work of physical forces when these are under the combination and direction and control of Mind." But this is not "the teaching of the great masters" whom Dr. Carpenter names in his letter.[1] To some of them, at any rate, such a needless restriction of the argument to special adaptations in "organic nature" seemed unwarrantable, and since Mr. Darwin has shown how these special adaptations may be proximately explained by the operation of certain physical causes, the tide of theistic opinion has more than ever turned towards a still more "fundamental proposition" of the argument from Design, viz. that the harmonious uniformity of Nature as a whole demands some one co-ordinating principle as its explanation. And when from this proposition it is argued that the principle in question must be of a psychical character, the argument belongs to the province of what I have called metaphysical teleology. This, indeed, is merely the "Cosmo-theology" of Baden-Powell, who saw very clearly the distinction which I have endeavoured to present, and while inveighing more heartily than I have done against "the narrow and unworthy form in which the reasoning has been too often conducted," maintained that the "fundamental proposition," "the very essence of the whole argument, is the invariable preservation of the principle of *order*," &c.

Lastly, I do not understand the Duke where he says that I am much mistaken if I "suppose that the present generation is satisfied with the purely materialistic explanations of adapted structures which are erroneously supposed to be the final result of Mr. Darwin's theory." I have not said anything to imply that I supposed these explanations to be "purely materialistic." As a matter of individual opinion I do not think that in themselves they are. I see plainly enough that they have reduced the "exquisite adaptations conspicuous in organic nature" to the same general category of physical causation as all other phenomena in the physical universe; but for this very reason, if for no other, I should fail to see that they can be "purely materialistic" in the sense of touching the transcendental or extra-scientific question of Theism.

Having thus stated my views at some length, I shall take no further part in this correspondence, unless it should appear that some further explanation is desirable.

George J. Romanes

[1] Except, perhaps, Mill, who thought highly of this form of teleology. But he also thought that if Mr. Darwin's "remarkable speculation" should be established as a truth of science, it would seriously "touch" the argument, as showing that "creative forethought is not absolutely the only link by which the origin of the wonderful mechanism of the eye may be connected with the fact of sight," &c.

Prof. Stokes's Lectures on Solar Physics

The subject of these lectures (Nature, vol. xxiv. pp. 593, 613) related primarily to the sun, and I was concerned with certain magnetic or electrical phenomena which are observed at the earth's surface only in so far as they related to the elucidation of the physics of the sun. Accordingly these collateral subjects were treated only very briefly, and I did not attempt to give anything like a history of the discoveries which have been made in them, even as regards the portions which bear more immediately on the physics of the sun. Indeed in many cases I designedly refrained from mentioning names, lest the hearers should suppose that I was giving a history of the subject, and those whose names might not appear in the very imperfect notice which it would have been should feel aggrieved. When a phenomenon was well known I generally contented myself with referring to it as such. Thus, for example, in alluding to earth-currents I spoke of them as what the progress of telegraphy had made us "familiarly acquainted with"; I said nothing about their discovery by Mr. Barlow, as described in his important paper published in the *Philosophical Transactions* for 1849, though it was a paper I had studied in connection with the lectures. I hope this example may suffice to prevent any one whose name does not appear from feeling annoyed at the omission, and to prevent the readers of Nature from taking my lectures for what they were not intended to be, namely, a complete history of the subject. I take this opportunity of referring to one passage in my second lecture (Nature, p. 415, a little above the figure), where I say "we might not have tension enough to produce such a discharge [*i.e.* a flash of lightning], the resistance to the passage of electricity from one portion of the air to another, which at any rate would be comparatively dry compared with what we have in warm latitudes, would prevent it by itself alone." These words, without actually asserting, seem to imply that the resistance to such a discharge through moist air would be less than through dry. My attention has been called by a friend to the fact that it has been found by experiment that moist air insulates as well as dry. I have not met with experiments tending to show whether the resistance to a *disruptive* discharge is the same or not in the two. Be that as it may, it does not affect what follows; for we know as a fact that thunderstorms are absent in high latitudes.

Cambridge, November 8 G. G. Stokes

The Society of Arts Patent Bill

It appears that "the draft of a Bill for the Amendment of the Patent Laws has been prepared by a committee of the Society of Arts, and is published by the Council of that Society for consideration."

From the printed bill so prepared and published the following extracts are made:—

Extract from the Proposed Patents for Inventions Bill.

Section 3. "An invention is deemed new for the purposes of this act if it has not been published or publicly used in the United Kingdom, the Channel Islands, or the Isle of Man within the thirty years immediately preceding the date of the application of a patent for it.

"5. A patent may be granted under this act for:—

"(*a*) Any manufacture or any product not being a natural product;

"(*b*) Any machine, or any means of producing any manufacture, product, or result;

"(*c*) Any process or method of producing any manufacture, product, or result;

"(*d*) Any part of a machine, means, process, or method of producing any manufacture, product, or result.

"8. *Commissioners of Patents and Examiners.*

"(1) There shall be a Board of Commissioners of Patents for Inventions, in this act referred to as the commissioners:—

"(2) At any time after the passing of this act Her Majesty may, by warrant under the Sign Manual, appoint three persons to be commissioners, of whom one shall be experienced in engineering, one shall be experienced in chemistry, and one shall be experienced in the law.

"9.—(1) The commissioners may from time to time after the passing of this act, subject to the approval of the Treasury, appoint such persons qualified by knowledge of manufactures or science or arts, as they see fit, to be Examiners of Patents.

"*Infringement of Patents.*

"57. An action or other proceeding for infringement of a patent shall not after the commencement of this act be commenced in any of Her Majesty's Courts of Justice in England.

"58. For the purposes of this act a person is deemed to infringe a patent if he copies altogether or in part the invention of a patentee with the view of effecting the same or a like object, and fails to establish any of the pleas allowed by this act in a proceeding for infringement.

"59.—(1) A patentee may complain of any infringement of his patent to the commissioners.

"(2) The complaint shall be heard and determined by the commissioner (other than the legal commissioner) who is best acquainted with the subject-matter of the complaint, assisted by a legal assessor to be appointed for the purpose by the commissioners.

"(3) An appeal shall lie from the decision of the tribunal thus constituted to the three commissioners, who shall hear the complaint *de novo*, and their decision shall be final.

"(4) The commissioner or commissioners sitting to hear any complaint may decide all questions of law and fact, &c.

"60. The pleas allowed by this act in a proceeding under this Act for infringement of a patent are—

"That the particular matters alleged to be infringed do not show sufficient invention to justify the grant of a patent, or are not new within the meaning of this act;

"That the patentee is not the true inventor of the invention, or of so much of it as is alleged to be infringed;

"That the matters complained of do not amount to infringement;

"That the claim of the patentee as respects the matters complained of is not stated with sufficient clearness;

"That the specification is, as respects the matters complained of, incomplete or misleading;

"That the patentee, as respects any matter complained of, withheld that which he knew to be a better description than that given in the specification."

. . . .

In commenting upon the above extracts it may be remarked that one main object of this bill appears to be to raise "*experts*" to the dignity and duties of the judicial bench. It is something quite new in the legal history of this country to make a man a judge because he has been frequently examined in court as a witness, and has shown considerable skill in baffling a hostile counsel.

The originality of such a proposal cannot be disputed, and accordingly the advocates of the present bill are justified in stating that it "provides for the trial of patent cases in an entirely new *manner*." What that manner is will be understood by referring to some clauses in the bill, the provisions of which are admirably non-legal in their phraseology.

By Section 57, "An action or other proceeding for infringement of a patent shall not, after the commencement of this act, be commenced" (in the only place where it can be brought, viz.) "in any of Her Majesty's courts of justice in England."

By Section 59, "A patentee may complain of any infringement of his patent to the commissioners."

Who then are to be the commissioners who are to stand in the place of the Lord Chancellor, the Master of the Rolls, and the law officers of the Crown, and who are to assume the functions of Judges of the High Court in ruthless disregard of the operation of the existing law?

By Section 8 they are to be three persons, "of whom one shall be *experienced* in engineering, one shall be *experienced* in chemistry, and one shall be *experienced* in the law." That is to say, they shall consist of two experts and a barrister.

To them the trial of all actions for the infringement of patents is to be relegated, but the proceeding is not to be called an action, it is to be "a complaint," and pleas only are to be raised by the defendant. It is here that the reformers, assisted by their barrister, show a wonderful capacity for disintegrating the law of patents.

They begin by defining the subject matter of a patent. This opens an opportunity for a display of strength, and they complacently remark that "at present the ancient definition of the Statute of Monopolies is in force, but, as a matter of fact, the question of subject matter depends wholly on the decision of the courts."

This is true, for we have from the period of James I., and especially since the invention of the steam-engine, a series of judgments which have enunciated with remarkable clearness and force the principles which should guide the courts in dealing with any future patent wherein it may be doubtful whether or not the thing patented is the proper subject for a patent right.

But instead of deciding any new case upon principle, our reformers give us a definition, or rather they give four definitions, the third of which is large enough to swallow all the rest, and would probably satisfy the most ardent inventor.

Hereafter the subject of a patent shall be

"*Any method of producing any result.*"

In spite of the protection afforded by the able Commissioners and their far-reaching staff of examiners, it may be doubted whether the public will feel quite safe in allowing monopolies to grow under the light of this definition. It may seem perhaps a little too general, it may include a few things more than the reformers have dreamed of.

Next, as to priority of invention:—

According to the Statute of Monopolies, patents may be granted for fourteen years for the "sole working or making of any manner of new manufacture within the realm to the *true and first inventor and inventors* of such manufactures which others at the time of making such letters patent shall not use," &c.

Hitherto a patentee must be the *first* inventor of the invention for which a patent is granted. Hereafter this distinction is abolished. "An invention is to be deemed *new* which has not been *published* or publicly used in the United Kingdom within thirty years immediately preceding the date of the application."

Lord Westbury has laid down "that the prior knowledge of an invention to avoid a patent must be such a knowledge as will enable the public to perceive the very discovery and to carry the invention into practice."

But inventions are now to be swept away by neglect and disuse. A process of de-publication is originated, whereby after thirty years neglect an invention may be deemed never to have been published, and the books wherein it has been described may be regarded as non-existent.

It has been a maxim of the law that when the public have once become possessed of an invention by lawful means, the right to use it can never be taken away from them. All this is done away with.

In what manner the promoters of this bill intend to work out their scheme of giving new birth to old inventions can hardly be understood from the above definition of a new invention, but the clause would appear to lead to endless confusion and uncertainty.

Next, as to infringement:—

By Section 58 "a person is deemed to infringe a patent if he copies altogether or in part the invention of a patentee with a view of effecting the same or a like object, and fails to establish any of the pleas allowed by this act in a proceeding for infringement."

The pleas are quoted in our extract from the bill, and a defendant may plead:—

"That the claim of the patentee as respects the matters complained of is not stated with sufficient clearness."

At present, as Lord Justice James has pointed out, there is nothing in the Statute of Monopolies or the patent law which says anything about claims. The legitimate object of a claim is the protection of the patentee, and a specification may be perfectly good without any claim at all. If there be a claim, the specification and claim are read together, and the claim must be construed with reference to the whole context of the specification.

According to the old practice a defendant would plead that the specification (whereof the claim, if there be one, forms a part) is insufficient.

According to the proposed bill the plea is to take the form:— That the *claim* is not stated with *sufficient* clearness. A plea to the sufficiency of clearness is somewhat embarrassing to a lawyer. Has it any meaning? and if so, what does it mean? The clearness which satisfied the patentee when he applied for his patent may not be sufficient to satisfy the commissioners when they are sitting in judgment. There may be some amount of clearness, but not enough. In the end, a patent may be wrecked on a mere verbal criticism, the very thing which the courts of law now set their faces against.

The infringement of a patent *only* takes place when a man *copies* the invention forming the subject-matter thereof. To limit an act of infringement in this way is absurd, and would

not be tolerated for an instant, as any patent lawyer would know.

As a matter of fact, there is a case pending which shows the risk of inventing new law. A company has brought an action for the infringement of a patent for making dynamite, the question being whether a man infringes a patent by acting as custom-house agent for admitting into this country a quantity of dynamite made abroad in infringement of an English patent. The Court of Appeal has given its judgment, and the case may go to the House of Lords. None of the six pleas enumerated in the draft bill will raise the question. And they will not raise another question which came up during the trial. The plaintiff company was formed to take over the dynamite patent from a prior company which then ceased to exist. The prior company assigned the patent to the plaintiffs with some very large words as to legal rights, and it became necessary to decide whether or not the second company could sue for infringements of the patent committed while the first company held it. The defence, that the right to sue for a tort is not assignable, could not have been raised under the proposed statutory pleas. Any plea which puts in issue the title of a complainant is inadmissible.

Lastly, as to the trial of a complaint of infringement :—

By Section 59 a complaint is to be heard in the first instance by the expert commissioner who is best acquainted with the subject matter. This judge is to be guided by a legal assessor, who will direct his mind into legal channels.

"From the decision of the tribunal thus constituted" (*sic*) an appeal will lie to the three commissioners, that is to say, to the original expert who has given his decision, to his brother expert, who is not experienced in the subject matter, and to the legal expert.

In other words, suppose the patent to be for a mechanical invention, and that we have three commissioners, A, B, C, of whom A is an engineer, B is a chemist, C is a lawyer.

A hears the case and gives his judgment ; B knows nothing of mechanics, and reviews A's judgment with the advantage of having A at his side to keep him in the right path according to A's views, while C acts as a sort of legal adviser, it being part of the scheme that there shall be no models, without which it can scarcely be hoped that B and C will ever get so far as to understand the invention.

This is the mode of trial which it is gravely proposed to substitute for the present inquiry in a court of law, with a right of appeal, first, to the Court of Appeal, and afterwards to the House of Lords.

Here ends one part of the new bill. The procedure in obtaining a patent can only be carried out if commissioners are appointed according to the provisions already discussed. This will I appear to be too improbable to justify any further encroachment upon your space.

LEX

"The Lepidoptera of Ceylon"

THE Colonial Government has recently presented to the library of this establishment Parts I. and II. of the work above named, for the publication of which it granted a large sum of public money. The origin of the book was the existence here at Peradeniya of a very fine series of original drawings made during a course of years by the well-known botanical draftsman in the employ of the Gardens—Mr. William de Alwis—under the careful supervision of my eminent predecessor Dr. Thwaites. The plates now published are copies of these figures (the originals are in the Colombo Museum), and to these, Mr. F. Moore has added brief technical descriptions. As a botanist it would be presumption in me to express an opinion as to the merit of the text of an entomological book. There are thirteen new genera in the first part and six in the second, but only three out of the nineteen contain any new species ; so at all events we get plenty of changes in the names of many long and well-known butterflies. But in the interests of scientific literature in general, I feel bound to enter a protest against the legend printed at the foot of every plate, "F. C. Moore, del. et lith.", as it is incorrect as to the facts. I have already stated by whom the figures were really drawn ; it is however only fair to the unassuming Sinhalese artist to allow that as put on the stone and published they are very greatly inferior to the admirable originals. One would like to think that it was a consciousness of this that led Mr. F. C. Moore to substitute his own name for that of W. de Alwis. But however this may be, it is time that some explanation was given by him of what looks like very shabby treatment of one of the best and most deserving natural history artists of the East.

HENRY TRIMEN

Royal Botanical Gardens, Peradeniya, Ceylon, October 10

An Alleged Diminution in the Size of Men's Heads

WHEN the hatter's note was brought before the Council of the Anthropological Institute, I supported its reception and publication ; my own observations have led me to the same conclusions. Setting aside for the moment the consideration of the authenticity of the statement—and I am not surprised that Prof. Flower should ask for more evidence—I would beg to call attention to the statistical results affecting infantine mortality, which are so well known to us in the statistical world. As we all know, it is a matter of congratulation that the rate of mortality in the periods from birth to two years, and from that to seven years, has much diminished in this country. This being so, the result is inevitable that many of the weaker infants that in a bygone day did not survive have now been saved ; and their survival means the survival of so many weaklings. It appears to me that this is going on in the United States and in many neighbouring parts of Europe. The question of degeneracy under sanitary influence is well worthy of attention and investigation. While on the one hand we see in the streets fewer cases of deformity and of squinting owing to orthopædic advances, there are many stunted individuals. The ears appear to me to be below the old standard in men and women. A well-formed ear was much more common in England than now. It also seems to me that the period of maturity in men (not puberty) is often later. The remark has been made that frigidity is more prevalent in women. It has come under my notice that the children of fine parents are often stunted, not belonging to the short races in the country, but being really stunted. We must always allow for a portion of the offspring belonging to the tall races, and a portion to the short races in the same family in England. My own belief is that the women are better than the men, and that when the effects of sanitary and medical improvement have become constant, that even the inferior women will exhibit a greater tendency to normal production. It is possible that the evil may be to some extent corrected by barrenness and frigidity. Looking back, I can find no effective cause in tight-lacing, as bad formerly as now, thicker or thinner hair since wigs, nor in wearing the hat.

32, St. George's Square, S.W. HYDE CLARKE

Sound-producing Ants

WITH reference to a remark of Mr. S. E. Peal's (NATURE, vol. xxiv. p. 484) to the effect that white ants emit sounds, but not in rhythm, I have to observe that I have frequently heard white ants emit sounds with the most perfect rhythm, when, in the years 1857–1860, I was engaged in the Geological Survey of Trichinopoly, &c. On several occasions it happened that my tent was pitched on a piece of ground infested with white ants, and it was the custom of my servants to spread a thin layer of straw beneath the *satrinji* or cotton carpet that was laid on the tent floor. Often, when sitting in the tent in the quiet of the evening, I have heard the white ants at work in the straw, emitting perfectly rhythmical waves of sound at intervals of about a second, or perhaps rather more. If they were disturbed by raising the *satrinji*, the sounds ceased : to be resumed however after a minute or two, when all was quiet again.

Simla, October 15 H. F. BLANFORD

Song of the Lizard

ANY one who has been in the South of Europe in the summer may have often heard a peculiar sound in the fields or amongst low herbage. The sound is like *wheet-t'wheet* repeated two or three times at short intervals. I have often been puzzled as to what animal it proceeded from, and should have supposed it to be some orthopterous insect, but that on getting to exactly where the sound had come from, it would again be heard at a distance of some five or six yards without having been seen. Last June, near Ajaccio, I believed I solved the puzzle. After the *wheet-t'wheet* a small lizard darted across some unusually bare ground, and, once again under cover, recommenced its song. Our great authority, Dr. Günther, is not aware of any true lizard having any vocal power (geckoes have a *tchet-tchet*—not often heard—are generally nocturnal, frequenting houses or old walls, occasionally hiding under stones during the day).

Perhaps the ability of some lizards to produce sounds such as I have here described may not be new to some of your readers.

1, Burlington Road, W., October 31 FRANCIS P. PASCOE

SEALS IN LAKE BAIKAL.—A. H. Keane wishes to know what authority there is for the statement made by E. Réclus ("Géographie Universelle," vi. 741) that seals outwardly resembling the *Phoca fœtida* of Spitzbergen are found in Lake Baikal; also what theories have been advanced to explain the presence of these Cetaceans in a freshwater lake over 1300 feet above sea-level.

NAPLES ZOOLOGICAL STATION.—For the terms on which permission can be obtained to work at the Naples Zoological Station, W. B. should write to Dr. Anton Dohrn, Stazione Zoologica, Naples.

MELAPTERURUS ELECTRICUS.—Keep it in an aquarium of fresh water, not too cold.

REV. J. F. T.—See the notice prefixed to our Correspondence Columns.

CHARLES W. HARDING.—You should communicate with the widow.

SEA FROTH

IN a letter written by my nephew, Mr. Ernest Gladstone of Aberdeen, describing the recent storms, he says: "When we got within a quarter of a mile of the sea we were astonished to see great flocks of foam, like snowballs, flying in all directions. A little further on we came to one of the large hollows in the links, and we saw a sight none of us had seen before; for the whole hollow, about 100 yards long and 50 broad, was one sea of slimy foam, of which a great part must have been about 10 feet deep. This was tossing up and down as if it were the sea itself. The waves of water broke far out at sea, but great rollers of foam kept rolling in towards the links, making it impossible to come near the sea without wading up to your waist in foam for nearly a quarter of a mile, and occasionally meeting a foam-wave up to your neck."

There is nothing unusual in this phenomenon, except the large scale upon which it took place. Almost every visitor to the seaside during rough weather must have observed the formation of a persistent sea froth, which is often carried great distances by the wind. The account, however, recalled to my memory some observations on the cause of the phenomenon which I made last year at Ilfracombe.

The white foam of a breaking wave, under ordinary circumstances, disappears almost as quickly as the small bubbles of entangled air can rise through the water and burst at the surface. It occurred to me that there must be something dissolved in the sea water which gave rise to the formation of the more persistent froth, and the broken and bruised sea-weed suggested itself to my mind as a probable source of such a substance. A quantity of it was therefore gathered, allowed to stand for several hours, till in fact it had run down to a liquid, and then filtered from the dirt and organic *débris* with which it was mixed. The clear water thus obtained gave a persistent froth, like that of beer, whenever it was shaken, and I subsequently found that it contained a considerable amount of organic matter. There was no distinct indication of anything albuminous.

In order to ascertain whether this property was due to broken sea-weed, two bottles were filled with ordinary sea water. Into one of these was put freshly-torn pieces of those kinds of fucus and other marine plants which were found growing between high and low water-mark, and in the other were placed strips of healthy laminaria freshly gathered from the lower zone. The bottles were violently shaken for a few minutes. The first gave a foam which quickly disappeared, while the second produced a froth which would remain more than twenty-four hours before all the bubbles broke. It may be observed in passing that this sea-froth, whether naturally or artificially prepared, becomes very iridescent on standing.

It seems fair to conclude, therefore, that the formation of this persistent froth is due to the destruction of the sea-weed—not of that which is tossed about by every tide, but of the laminaria which is uprooted and torn by the waves only when the violent agitation of the sea reaches a sufficient depth. J. H. GLADSTONE

OUR WINTER REFUGES—VENTNOR

IT is now upwards of half a century since Sir James Clark's classic work "On the Influence of Climate" in the prevention and cure of chronic diseases appeared, and among the more important results which followed its publication was the establishment of stations in this and other countries for meteorological observations, by which alone the climates of various sanatoria might be accurately compared. To Sir James is due to a great extent the merit of having placed the investigation of this important department of practical meteorology on a sound basis.

The late Dr. Martin of Ventnor was one of the most intelligent and active of the co-operating band of observers whose services were enlisted in the inquiry. A valuable series of observations was begun by him in the end of 1839, in establishing which Mr. Glaisher kindly gave his assistance and advice. The observations have since been carried on uninterruptedly, and they are evidently, particularly those of temperature and rainfall, of such a quality as quite to meet the objects aimed at. The results are presented and summarised in a just-published volume [1] by Dr. Whitehead with ability, in their bearings on the climatology of Ventnor.

The Isle of Wight occupies a high place as a favourable and commodious residence throughout the year for a large class of invalids, owing to the variety which it presents in point of elevation, soil, and aspect, and to the configuration of its hills and shores, which give distinctive climatic peculiarities to certain districts, notably to the Undercliff. These peculiarities are of no inconsiderable value in the treatment of those diseases which require a mild, equable temperature, a comparatively small rainfall, and protection from certain noxious winds.

The Undercliff extends for nearly seven miles from Bonchurch to Blackgang, with an average breadth of a third of a mile, and is completely sheltered from the north-east, north, north-west, and west winds of the Uppercliff—a range of lofty downs of chalk and sandstone which rise boldly behind the successive terraces in elevations varying from 400 to 600 feet. Since the Undercliff terminates in an unbroken perpendicular sea-cliff from 60 to 80 feet in height along its whole extent, the situation is not close or confined, but open and airy, and affords, besides, certain material advantages in the mitigation of sea fogs and low night temperatures. The broad belt of the Solent and Spithead separating the Isle of Wight from the mainland, and the position of the Undercliff in the extreme south of the island, considered with reference to the prevailing winds of the Channel, are also important factors in the climate of the district.

In more recent years several other meteorological stations have been established in other parts of the island and on the adjacent coast of Hampshire, from the observations of which a comparison may be made of the climatologies of this part of the South of England.

On an average of the last twenty-one years the annual rainfall of Ventnor was 30·00 inches, being all but identical with that of Osborne and Bournemouth. The amount rises successively at Hurst Castle, Ryde, and Newport, the rainfall at the last place being 34·20 inches,

[1] "The Climate of the Undercliff, Isle of Wight, as Deduced from Forty Years' Consecutive Meteorological Observations," by J. L. Whitehead, M.D.

or fully four inches in excess of Ventnor. While the rainfall of the comparatively low-lying coasts of the Isle of Wight and Hants is about 30·00 inches, the amount along the coast from Selsey Bill eastward as far as Folkestone is two inches less, but on the coast of Devon, from Lyme Regis to Start Point, it rises to from 33·0 to 37·6 inches—figures of some importance in their relations to the sanataria of these coasts.

One of the most interesting results disclosed by these forty years' observations is the successive gradual increase of the rainfall decade by decade, the means being respectively, beginning with the decade 1840-49, 25·72, 28·45, 29·16, and 31·11 inches. This feature of the rainfall holds also in several other districts of the United Kingdom; whereas on the other hand other districts present a very different distribution during these forty years, that of some districts being just the reverse of Ventnor. The mean rainfall of Ventnor for the twenty years ending 1859 being 27·08 inches, and for the twenty years ending 1879 being 30·14 inches, points to the necessity there is that care be taken to employ the same terms of years in comparing the rainfall of different districts.

The mean temperature for the forty years is 51°·6; the coldest month being January, 41°·9, and the warmest August, 62°·7. As January may be taken to represent the coldest months of the year, or the season when the climate of the Undercliff affords the greatest advantages to invalids, the following comparison of its temperature with that of other places in the South of England may be stated:—It exceeds the temperature of Sidmouth by 0°·2; Bournemouth by 0°·6; Osborne by 1°·2; and Folkestone, Eastbourne, Brighton, and Clifton by 1°·7; but on the other hand its January temperature is lower than that of Torquay by 1°·1; the extreme south-west of Cornwall by 2°·6; and Scilly by 4°·4. In this connection it is to be noted, as already pointed out, that along the coast to eastward the rainfall is less, and the climate therefore somewhat dryer; and to westward the rainfall is larger and the climate therefore wetter; and this latter remark applies with increased force as respects all places to the westward of Prawle Point.

The climatic advantages of the Undercliff, due to its southern insular position and distance eastward from the Land's End, by which the force of the west-south-west winds are much weakened before arriving there, are perhaps most apparent on examining the columns of minimum night temperatures. In this remark we refer to the general teaching of the figures, which indicate a remarkable protection against the inroads of low temperatures, with their malignant influence as respects a large class of invalids; and not to such singular temperature phenomena as the occurrence of 17°·0 on January 22 last, during the great snowstorm of that period, for if great or exclusive weight be given to such temperatures the winter climate of the Undercliff must yield to that of many insular situations in the north-west of Scotland.

As compared with London the mean temperature of the Undercliff is 2°·4 less in July, 0°·8 in August; but in September it is 0°·7, and in October 2°·2 higher. In other words the heat of summer is greatly mitigated on the south shores of the Isle of Wight, and prolonged further into the autumn months, thus greatly extending the time during which invalids might sit out in the open air with impunity.

Dr. Whitehead's book is handsomely bound, carefully got up and printed, and the tables are introduced to the reader by a well-written and sensible preface. When the work, however, passes into a second edition, one or two improvements might be introduced. A table of monthly mean temperatures of the several years might be given similar to that of the rainfall on pp. 29, 30. In this edition no mean temperatures of the months are included, and to ascertain these the whole of the temperatures must be copied out from pp. 8 to 23, and the averages struck. The table of monthly barometric means requires careful revision, several of them showing transposed and inverted figures, while a few others require to be compared with the original observations from which they are calculated—transpositions and inversions of figures not being so readily seen in barometric as in thermometric and rainfall averages. The work, however, is an exceedingly valuable addition towards a correct knowledge of the climatologies of the South of England, which holds out to invalids the best winter refuges of the British Islands.

INTERNATIONAL GEOLOGICAL CONGRESS

THE second session of the International Geological Congress was recently held at Bologna, commencing on Monday, September 26. About 200 geologists were present, but only eight of them represented the English-speaking nations. These were: Prof. James Hall (representing the United States), Dr. T. Sterry Hunt (Canada), W. T. Blanford (Geological Survey of India), W. Topley (Geological Survey of England), Prof. T. McK. Hughes, J. A. Phillips, E. B. Tawney, and Col. Tabuteau.

The arrangements made for the Congress were admirable in every respect, thanks to the energy and forethought of Prof. Capellini and M. Giordano.

The first session of the Congress was held at Paris in 1878. At that meeting certain geologists were nominated to organise committees in each country to discuss and report upon the various questions requiring attention. These are classed in three main divisions: (1) the unification of geological nomenclature (of this committee Prof. Hughes was nominated president for England); (2) the unification of colours, signs, &c., employed in geological maps and sections (of this Prof. Ramsay was nominated president for England); (3) nomenclature of species; on this subject no action has been taken in England. Prof. Hughes' committee has been for some time at work, and notices of its progress have at various times appeared in this journal. The Committee on Geological Maps was started in England much later, but a report of its work was read at the York meeting of the British Association. At that meeting the Association gave a grant of 25*l.* in aid of the proposed International Map of Europe.

Some preliminary meetings were held at Bologna on Sunday, September 25, but the real work of the week commenced next day, when the Congress was formally received by the Syndic and Municipality of Bologna. At the opening meeting the chair was occupied by M. Berti, Minister of Agriculture and Commerce, who had been deputed to represent the King. The chairman was supported by M. Q. Sella, honorary president, and M. Ed. Hebert, ex-president. The bureau was formed as follows:—President: Prof. Capellini; Vice-presidents, representing various nations, amongst them—J. Hall (United States), Sterry Hunt (Canada), W. T. Blanford (India), Prof. Hughes (Great Britain), Prof. Daubrée (France), Prof. Torell (Sweden), &c.; General Secretary: F. Giordano; Secretaries: Bornemann, Delaire, Fontannes, Pelar, Taramelli, Topley, Uzielli, and Zezi. The Congress had offered prizes for the best essays upon the colouring, &c., of maps. These were awarded to MM. Heim of Zürich, Carpinski of St. Petersburg, Maillard of Lausanne.

At the conclusion of this meeting the Congress adjourned to the excellent new Geological Museum which has been formed under the direction of Prof. Capellini. The Via Zamboni, in which the Museum is situated, was lined by representatives of all the ancient trade guilds of Bologna, each with its banner. M. Sella took especial pains to explain to the American and English visitors the history and present position of these interesting old societies.

The first sittings of the Congress were devoted to a

discussion of the names to be employed in describing the various groups of beds, on which subject a preliminary report had been prepared by M. Dewalque. English geologists have always used the term "formation" to denote a group of beds, sometimes large, sometimes small; thus we should speak of the Silurian formation or of the Liassic formation. The word is rarely used in this sense by Continental geologists; they use it only as descriptive of the mode of origin or *mode of formation*, or as descriptive of the nature of the material composing the rock. Thus they might speak of the "chalk formation," but never of the "cretaceous formation." It was necessary for the English to make some concession on this point, which should satisfy the representatives of other countries without unduly committing English geologists. Prof. Hughes proposed a resolution recommending the use of the word "formation" as far as possible in the Continental sense.

A long discussion followed respecting the value to be attached to certain words in descriptive geology, and ultimately it was resolved to employ them in the following order, the most comprehensive term being placed first:—

Divisions of sedimentary formations.	Corresponding chronological term.
Groupe	Cycle
Système	Période
Série	Époque
Étage	Age

With regard to the term *Série* a difficulty occurred, in consequence of there being no precisely similar equivalent in the German or Russian languages. This question was referred to the Council, who recommended the use of the terms *Série*, *Section*, or *Abtheilung* as equivalent terms. Also as regards the term *Assise* (subdivision of *Étage*) a reservation was carried leaving each nation to choose the word which most nearly expresses the same meaning (*beds*, *couches*).

There was much more down for discussion, especially with reference to proposed uniformity of language, terminations of words, &c; but it was resolved to postpone these questions till the next meeting of the Congress, by which time it might be possible to arrive at some common terminology for eruptive rocks, &c.

The second part of the work of the Congress related to the colours and signs employed in geological maps. On this subject a general report had been drawn up by Prof. Renevier, based upon the reports of various national committees. Much has been said about the solar spectrum and its order of colours, and Prof. Renevier's resolution, as originally drawn up, proposed a system of colour based on this natural order; but so many and important deviations from this natural order were recommended by different nations, that it was thought better to omit all reference to the solar spectrum. Resolutions were passed recommending the adoption of a common scale of colours for all nations, especially in view of general maps (*travaux d'ensemble*); but without reference to maps now in course of publication. The following colours were adopted:—

For crystalline schists of Pre-Cambrian age—bright rose-carmine.
,, ,, ,, unknown age—pale rose-carmine.
,, Palæozoic rocks (question reserved for Map Committee).
,, Trias—Violet.
,, Lias—Dark blue.
,, Jurassic—Blue.
,, Cretaceous—Green.
,, Tertiary group—Shades of yellow; the newer divisions to be the lighter tints.

The subdivisions to be shown by shades of the colour adopted, or by coloured lines; the darker shades denoting the older subdivisions. Sedimentary formations to be denoted by the initial Roman capital of the name of the formation; subdivision of formations to be shown, in addition to this, by the initial small letter of the name of the subdivision. Still smaller subdivisions to be shown by figures added to the other signs; the figures to be taken in chronological order—1 denoting the oldest subdivision. Eruptive rocks to be denoted by the initial Greek capital of the name of the rock.

The Congress resolved to prepare and publish a geological map of Europe, and for this purpose a committee was appointed. Any committee having representatives of all the countries of Europe would be too large; it was therefore necessary to limit the number of nations to be directly represented; at first this was fixed at five, but afterwards the committee was increased to eight. Great Britain received the largest number of votes, France coming second, Germany third. The committee was finally elected as follows:—Beyrich (for Germany, and also as director of the map); Daubrée (France); De Moeller (Russia); Giordano (Italy); Hauchecorne (as assistant director); Mojsisovics (Austro-Hungary); Renevier (Switzerland, and also as secretary); Topley (Great Britain). The map will be published at Berlin; the scale was fixed at 1 : 1,500,000; the cost is estimated at about 2500*l.*; and application will be made to the various Governments of Europe for monetary aid.

In most of the countries not directly represented, arrangements will subsequently be made by the committee; but it was settled that Austria should take charge of Turkey, France of Algeria, &c. (or of so much of that district as comes within the limit of the map), Great Britain of Palestine, it being hoped that much geological information, which may be available for this purpose, is in possession of the Palestine Exploration Society.

At a subsequent meeting it was arranged that a committee, formed for the most part of vice-presidents, should be formed to co-operate with the Map Committee with regard to questions of nomenclature, classification, &c. Prof. Hughes represents England on this committee.

One sitting of the Congress was devoted to a discussion of the nomenclature of species. Upon this question only the French committee had sent a report, and no great amount of work was done. The Congress, however, recommended the use of a generic and a specific name, to be followed, when necessary, by that of the variety. The nomenclature to be Latin or Latinised. When the original name of the genus is not preserved, the name of the author of a new specific name is to be placed within brackets.

At the close of the Congress an excursion was made to Florence, Pisa, and the marble quarries of Carrara. For this free tickets or a special train were provided for all members. At each place the municipality received the Congress and did its utmost to render the excursion a success. At Florence the new Museum of Natural History was inspected, and then the Congress adjourned to the crypt of San Lorenzo to place a wreath on the tomb of Steno (who died in 1687), and to hear an oration by Prof. Smidt of Copenhagen. At Pisa the Natural History Museum was visited, this being very rich in geological and prehistoric remains from the district.

An important result of the Congress has been the foundation of a Geological Society of Italy, of which Prof. Meneghini is president, Prof. G. Capellini vice-president, and M. Pantanelli secretary. So much good geological work is now being done in Italy that it is of great importance to collect the scattered workers into one central society.

The next meeting of the Congress has been fixed for 1884 at Berlin, with Dr. E. Beyrich as president; but preliminary meetings, with reference to the geological map of Europe, are to be held next year at Foix, in the Pyrenees (at the annual meeting of the Geological Society of France), and in 1883 in Switzerland. It was generally understood that the fourth meeting of the Congress would be held in England.

THE AUTUMN SKY[1]

II.

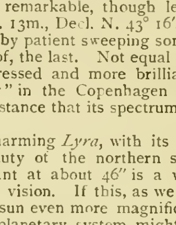
An attempt was made in a preceding paper to point out the most remarkable features of the planets that are at present so attractive for telescopic inquiry. We will now proceed to pass in review a few of the more interesting sidereal objects in that part of the heavens that is well placed for the observer. It is needless to say that within our limits nothing more can be expected than a very scanty selection, for the use of inexperienced students, of some of the most conspicuous of the many hundreds of double stars and nebulæ that are within the reach of ordinary instruments. We begin with the constellation *Hercules*, because it is rapidly gliding away from us, and the search for our first object should be undertaken as early as possible in the evening, especially if we are unacquainted with its position. The possessors, of course, of equatorial mountings and divided circles will readily find anything in our selection from its assigned place; but we propose to give such instructions as may be serviceable with altazimuth stands, aided by any common map, which will be occasionally supplemented by small diagrams. These, it must be borne in mind, correspond with a meridian position, and must be inclined one way or other to represent objects lying east or west of it.

If then we wish to find without an equatorial, set to R.A. 16h. 37m., D.N. 36° 41′, the great globular cluster in the constellation *Hercules*, known as M(essier) 13, we must look out west-north-west for a large triangle, nearly equilateral, of 3rd mag. stars β, δ, ζ, the left-hand angle of which at β is nearest the horizon; at the other end of this side is ζ; if we continue the line $\beta\zeta$ nearly as far again to the right, bending a little upwards, we come upon a similar star η, and between ζ and η, but rather nearer to the latter, our object is found. It is easily visible with the slightest telescopic aid, and discernible even without it in a clear dark sky. It will be instantly recognised as a round ball of misty light, which nearer the meridian would be of considerable brightness. It will not be favourably placed for examination; but those who have once caught sight of it will look out for it in a better position another year. At any time its resolution into stars will of course depend on the aperture; as this and the power are increased the mass will soon begin to sparkle, and the more brilliant points will rise out of the general haze; but it will require a large telescope to resolve it throughout. The great Copenhagen achromatic of 11 inches aperture in the hands of d'Arrest effected it with a power of 95. Its components, ranging according to Sir J. Herschel from 10 or 11 to 15 or 20 mags., must be thousands in number: his father had supposed 14,000. The state of compression, he observes, indicates not much greater density at the centre. Outliers surround it in streaky masses and lines; and the ball, according to the Earl of Rosse, is intersected by three dark rifts confluent towards the centre, which I have perceived, as *known objects*, with my 9⅓-inch mirror. This is unquestionably the finest specimen of a globular cluster visible in our latitudes; and even when the eye has recovered from its first surprise, it is never weary of reverting to this wonderful object. It may well be called wonderful, even at the distance at which we have to contemplate it. But imagination fails utterly to grasp the magnificence of such a scene, could we be transported to a standpoint two or three of its own diameters distant; or could we penetrate to the heart of the resplendent mystery, flaming on every side with suns innumerable, and where shade would be unknown and impossible. But are those thousands upon thousands suns indeed? We only know that they possess the solar character of intrinsic light; yet that there is something peculiar in that light appears by modern analysis, which finds the red end of their spectrum deficient; but as to their nature, or their magnitude, or their distance from us, or among themselves; whether they were formed as they are, or have been gradually aggregated through innumerable ages—of all this we know absolutely nothing, and nothing are we ever likely to know. Nor if, as it is natural to suppose, gravitation is an inseparable property of matter, can we conceive how that glorious accumulation can be permanent, or escape ultimate transmutation into a fresh form of existence by the final coalescence of its members. It has indeed been supposed that, under certain admissions as to proportionate distance and velocity, such a mass might be preserved in a permanent condition of rotation; but we are treading here too closely upon the impossible, and though all may continue sensibly unvaried for ages, yet a secret principle must be at work that will issue in a final catastrophe—the opening, it may be, of a new and more glorious existence. We beings of a day can but confess our ignorance and our nothingness in the contemplation of such an evidence of creative power and uncomprehended skill in what is but a minute speck to the keenest eye.

We should not leave this object without noting its beautiful configuration in a large field with neighbouring stars; probably only an optical vicinity. Yet who after all can say which may be the nearest, now that it has been so clearly shown that there is but a precarious relation between apparent magnitude and actual distance?

While we are in this region we should make an attempt to see another remarkable, though less-known, cluster, M 92, R.A. 17h. 13m., Decl. N. 43° 16′.[1] It may be found without circles, by patient sweeping some distance above, and to the left of, the last. Not equal in size to M 13, it is more compressed and more brilliant in the centre; "*formosissimus*" in the Copenhagen telescope. It is a singular circumstance that its spectrum resembles that of M 13.

Next, ever-charming *Lyra*, with its glowing sapphire, *Wega*, the beauty of the northern sky, whose minute 11 mag. attendant at about 46″ is a well-known test for sensitiveness of vision. If this, as we are warranted in supposing, is a sun even more magnificent than our own, a search for a planetary system might not be hopeless. Several observers have actually seen minute points in its immediate neighbourhood, but there is little agreement about them, and they remain for closer investigation. The accompanying diagram may serve to guide us to



1.

some other interesting objects here. Above *Wega*, a little to the left, are the two well-known pairs, ϵ^1, ϵ^2, with the intervening *debilissima*; long familiar to observers. It is no very uncommon feat, though one which I could never accomplish, to separate ϵ^1 and ϵ^2 at 3½′ distance with the naked eye; the subdivision of the pairs, and the ruddier hue of one of the components of ϵ^1, will be apparent with a power of 50 or 60. There is of course an abstract possibility that this beautiful combination may be merely the result of coincident direction: but our optical sense revolts from the demand this would make upon it; and

[1] Continued from p. 10.

[1] This glorious object, discovered by Bode, is omitted in Sir J. Herschel's Catalogue.

mere inspection forces home upon us the persuasion that a physically-connected system lies before the eye. As regards each pair separately, the inference is already established by orbital motion—the mutual relation of the whole waits the examination of ages.

The *debilissima* may be watched for a suspicion of variable light. Some very minute points precede them.

ζ, next below and following *Wega*, is a grand wide pair, nearly 44″ apart, 5 and 5½ or 6 mags., topaz yellow and greenish, or, according to others, lilac. Such discordant estimates of colour are of frequent occurrence. They

2.

may arise from actual dissimilarity of vision, or an uncertain effect of contrast, or residual chromatic aberration; but we have to remember that these star-hues are often open to question from their feebleness, and especially from the absence of comparison with a light of standard whiteness in the field.

To the left of ζ a low power will show us δ^1 and δ^2 in a fine group, where some beautiful colouring will be found. One of the smaller stars has at times appeared to me of a pale ruby tint, on other nights not traceable. 24′ nearly north of δ^1 Burnham has detected a small pair (his No. 137), only 1″·2 apart, and therefore a severe trial for ordinary apertures.

Further to the left the naked eye shows us two small stars at a greater distance: the uppermost, η, 5 mag., has a 9 mag. attendant at 28″; the colour is differently recorded as blue and pale yellow. Three small pairs lie near it. The other star, θ, is also worth looking at for its fine surroundings. But beautiful fields are throughout more or less the character of this constellation.

Lower down, and brighter than the two last-mentioned, are two considerable stars, β and γ, of which the right hand one, β, is the centre of a minute group; but more remarkable for variation in its light, with superposed inferior variations, completed in about 12d. 22h. Its

3.

colour is also questionable, yellow, or none. But greater interest attaches to these two stars as guides on either side to the wonderful annular nebula, M 57, the brightest of its class, easy with very slight optical means, refractory with the highest. Its light has been noticed, ever since Schröter's time, to be a little unequal in different parts, and may possibly be variable; the interior is gauzy and streaky, according to the Earl of Rosse, who also represents some exterior wispiness. The idea of its starry composition, maintained by Secchi and Chacornac, has been dispelled by Huggins, whose spectroscope shows only gas. But how produced? how accumulated into that extraordinary shape? how heated into incandescence, and maintaining that temperature, at any rate since 1779, amid the alleged intensity of cold in space—here even conjecture must admit its helplessness. A minute star following it may perhaps be variable.

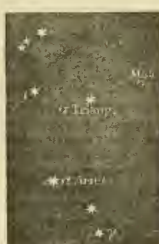
In sweeping from this region towards the galaxy, we shall cross an abundance of rich and lovely fields; but

4.

the galaxy itself, with a sufficient aperture and low power, is from end to end a scene of wonder and astonishment. Especially in some parts of *Cygnus* its magnificence exceeds all hope of description. But it is not only to be studied for its gorgeous profusion of suns—where in a short time many thousands pass before the eye—nor for the many beautiful pairs that it envelopes—such as the

5.

well-known β *Cygni*, with its elegant contrast; or χ (R.A. 19h. 42m. D.N. 33° 27′), inferior indeed, but very pretty; or the wide pair 61 (R.A. 21h. 1m. D.N. 38° 9′), whose parallax, the first well established, shows that they are nearer to us than the bright leaders of the constellation; or at the end of the right arm of the great cross, δ, whose minute comes at 1″·6 has proved such an annoyance to many a



6.

disappointed observer, who might however have succeeded in a twilight hour; nor again for its groups of irregular and artistic beauty; but for many peculiarities of arrangement, not altogether unrecorded, especially by Secchi, but scarcely adverted to as they deserve. Among the minuter stars, from perhaps the 8th to the 11th mag., configurations are not infrequent of such singular

regularity or peculiarity of arrangement that the idea of optical concurrence seems inadmissible. Triangles, squares, rhomboids, wreaths, festoons, coronets, indicate a collocation utterly inscrutable, but certainly not fortuitous. Such combinations are occasionally met with in other regions, but, as might be expected, are accumulated in the galaxy.

The glory of this sparkling zone, culminating in the splendours of *Cygnus*, is everywhere repeated in greater or less degree. *Aquila, Sagitta, Vulpecula, Lacerta*, to say nothing of more distant regions, all present fields of most gorgeous richness, which we must leave unnoticed. But before we finally cross this region to the other side, we must pause in *Vulpecula*, where, in R.A. 19h. 54m. D.N. 22° 23′, lies an especial mystery, the *Dumb-bell Nebula* (M 27). The search with the altazimuth will prove not difficult as guided by Diagram 2.

In mid-distance between *β Cygni* and *α Aquilæ* we we shall recognise a lengthened group of 4th and 5th mag. stars, the lowest in the figure, forming the constellation *Sagitta*. We may remark, in passing, that one of these, ζ, R.A. 19h. 44m., D.N. 18° 51′, is a very pretty wide double, the largest of which has been found by Alvan Clark, jun., to be an excessively close pair. Nearer to *β Cygni*, but to the left, is another less marked group, forming part of *Vulpecula*, close to one of the stars of which, in a rich field, we shall perceive two oval hazy masses in lateral contact, the nebula in question.

Like other objects of the same nature, this has been seen, or at any rate, drawn, in very dissimilar ways; it seems in fact almost inseparable from the character of nebulous light that its limits and gradations should be differently appreciated by different observers; and in this instance the additions resulting from larger apertures have almost obliterated the original idea; yet without suspicion of actual change. Minute twinklings are easily seen in the haze; and the Earl of Rosse finds a much greater abundance of stars than in the surrounding sky; yet he does not resolve it; and the spectroscope shows it as a huge mass of incandescent gas—apparently the little-comprehended element nitrogen.

Quitting now the galaxy for the region on its eastern side, we notice, a little above α Aquilæ, the familiar lozenge of *Delphinus* (a curious instance of configuration) the following or left-hand component of which, γ, is a noble pair of 4th and 7th mags. at nearly 12″, and somewhat differing in colour now, though Sir W. Herschel called them both white in 1779. Physical connection is inferred from an extremely slow relative movement; more decidedly from a motion through space common to both—an unsolved and insoluble mystery. South of γ, a little to the west is Σ 2725, a very pretty little couple, at 4″·2; possibly of binary character.

A little further south-east we shall find another less conspicuous group of small stars, chiefly in the form of a trapezoid. This is *Equuleus*. It is given in Diagram 3, where α is at the lowest angle.

Here γ, the 4¾ mag. star nearest *Delphinus*, forms a striking combination with one of 6th mag., and has itself been doubled by Knott with an 11 mag. comes at 2″·1. And beyond the limit of the trapezoid to the south-west we find a very fine triple, ε, R.A. 20h. 53m., D.N. 3° 50′, the two closest of which are a beautiful pair in slow rotation, whose distance, less than 1″, renders it an excellent test for a moderate aperture. The third star also appears to be physically connected with the others. λ, readily found by sweeping less than 3° north of the last, and a little east, is also well worth looking for: 6 and 6½ mags. at about 2″.

We shall now cross the border into *Pegasus*, the leader of which, in respect of position, ε, is represented in the same diagram; a bright yellow 2½ mag. star with 2 comites, 9 and 14 mags. Sweeping rather more than 2¼° north of this, about 14m. west (R.A. 21h. 24m., D.N. 11° 38′) we shall come upon M 15, a noble globular cluster, of similar character to M 13 in *Hercules*, but of smaller size. Sir J. Herschel gives the stars 15 mag. of his scale, running up to a central blaze, and more condensed there than according to the idea of equal distribution. It is not quite circular, and surrounded with outlying streams. Buffham, with a 9-inch "With" mirror, has detected a dark patch near the centre, and two faint rifts like those in M 13, traces of one of which I think I once perceived. This fine object deserves a long and steady gaze.

About 1° south of the cluster, a little west, we shall readily find a beautiful pair, perhaps slow binary, Σ 2799, both 6·6 mag. of Struve's scale, 1″·4 distant.

Ranging east and west, at some distance below *ε Pegasi*, we shall remark the subject of Diagram 4; part of *Aquarius*. At the east end a very remarkable pair, ζ, R.A. 22h. 23m., D.S. 0° 38′, will be found in the interior of an easily-recognised triangle of stars, not much differing in brightness. The magnitudes are given 4 and 4½; the distance 3″·6; the binary character is certain, and the period last assigned 1625 years. This is an excellent object for a small telescope, and will lead to many wondering thoughts as to the possible state of existence there. A much larger aperture will be required to secure Burnham's little pair, 8½ and 10 or 11 mag. at 1″·5, 11′ south of ζ.

To find our next object, M 2, R.A. 21h. 27m., D.S. 1° 22′, by sweeping, we must note its configuration in the diagram with α and β, two stars conspicuous for insulation in a dull region. It will repay the search, being, not indeed a brilliant, but a very interesting ball of several thousand very minute stars, 15 mag. of Sir J. Herschel, "a most superb cluster" in his reflector, "like a heap of fine sand," blazing in centre: D'Arrest sees it of irregular form. What an object, could we reach its neighbourhood!

But perhaps more surprising, though in quite a different way, is the next, H iv. 1—that is, No. 1 in Sir W. Herschel's fourth class—a noble specimen of what, from their equable light and defined edges, the illustrious discoverer termed Planetary Nebulæ. It lies in R.A. 20h. 58m., D.S. 11° 50′, and, to find it, we may carry a line through α and β nearly as far again, bending a little downwards: this will point out ν, a 5th mag. star, a little west of which we shall catch our object. It is tolerably bright, slightly elliptical, and of a pale blue tint. Lassell has seen a luminous well-defined ring in its interior; Buffham, with 9-inch mirror, an opening. The Earl of Rosse, besides many faint projections, finds a narrow ray on either side, making the whole a singular resemblance to Saturn with a very thin presentation of the ring. Yet here too is gas! and as it seems, nothing but gas! But whence? how? wherefore?

And now we pass to the left over a long and rather dull region from the triangle in *Aquarius* to the chief star of *Pisces*, at the extremity of the constellation, about 20° under the well-known three stars that mark the head of *Aries*. *α Piscium* with the head of *Cetus* east of it are shown in Diagram 5. It is a fine pair, 5 and 6 mags. at 3″·2, the tints of which, as well as the mags., have been described with greater discordance than can be easily explained. *α Ceti*, the next conspicuous star to the east, is a very beautiful specimen of a large orange star, with a blue companion at a little distance, the colour of which may possibly be due to contrast, or heightened by it: this might be ascertained by hiding the great leader behind the edge of the field. There is a pretty little pair near them. The next star to the right, γ, is a striking double, 2″·6 apart, 3 and 7 mags., yellow and blue (greenish, ruddy, or tawny to some eyes). Above and to the right of this is ν, 4½ mag., attended by a very minute companion, a glimpse star to Smyth, but much easier of late. Below ν, a little to the right, is δ, a line through which from α will point out a very remarkable variable, *o*,

or Mira Ceti, R.A. 2h. 13m. D.S. 3° 31'. This changes from 2 mag. to equality with a very minute companion in about 331d. 8h. 4m., but not without some uncertainty. Its colour, according to Sir J. Herschel, is a full ruby; I saw it so once, when about 10 mag., if it was the right star, but it was immediately clouded over: at another time, near *maximum*, pale yellow, without a trace of red. Flammarion also finds it by direct comparison less red than a gas flame. This tint would be an interesting object of study; but care must be taken in identification. Mira is now decreasing.

Having mentioned the head of *Aries*, we must recollect that γ, the smallest of the three stars, is a double, interesting as the first of these objects recorded by Hooke in 1664, and a fine object, nearly 9" distant. These three stars are introduced into this diagram as guides to *Triangulum* just above them, where we shall find our last two objects.

ι, R.A. 2h. 5m., D.N. 29° 44', topaz and green, an exquisitely coloured pair, $5\frac{1}{2}$ and 7 mags., distance 3"·5; perhaps in slow orbital motion. We shall pick it up about $\frac{3}{4}$° north of α, a little to the east. The other is a strange phænomenon,

M 33, R.A. 1h. 27m., D.N. 30° 4', about 1° north of α, and not far towards the west. Feeble as it is, it will be visible even with a very small aperture, from its great extent; fully $\frac{1}{2}$°, or the diameter of the moon, from north to south; but on the other hand may, from want of contrast, be imperceptible with any but a very low power. The elder Herschel thought it was resolved into the minutest possible stars; but this has not been confirmed. His son and d'Arrest find a principal condensation with subordinate nuclei and nebulous tracts; the Earl of Rosse, a flocculent and spiral structure, with curved intersecting branches; a strange, incomprehensible form.

Our space will not admit of an extension of this very meagre and imperfect selection, limited for the most part, for obvious reasons, to such portions of our autumnal sky as are rapidly passing away. T. W. WEBB

AN OBSERVATORY FOR HONGKONG

WE observe that Sir John Hennessy, the Governor of Hongkong, has succeeded in getting an item of twenty thousand dollars for an observatory and time ball passed by his Legislative Council in the estimates for the current year, in addition to a sum of ten thousand dollars voted for the same purpose last year. The advice of Major H. S. Palmer, of the Royal Engineers, has been sought by the Colonial Government, and in a valuable paper published in one of the most recent Government Gazettes, he details the advantages, imperial and local, which may be expected from a physical observatory in Hongkong. The favourable position of the island for certain observations, especially with regard to the typhoons of the China Seas, on meteorology generally, and on terrestrial magnetism, was first brought to the Governor's notice in September, 1879, through the Secretary of State for the Colonies, by Dr. Warren De La Rue, as Vice-Chairman of the Kew Committee of the Royal Society. He pointed out the extreme importance of obtaining accurate records of the magnetic and meteorological conditions of the China Seas. There are at present only four observatories at which continuous observations are taken on the eastern coast of Asia and the adjacent islands—one at Batavia, in Java, supported by the Dutch Government, one attached to the Russian embassy at Peking, one at Siccawei, near Shanghai, and one at Manila. The two last are supported by the Society of Jesus. It is pointed out that Hongkong divides the distance between Siccawei and Manila, and would consequently be a most valuable acquisition to the list. The support of the Government of the Colony for a limited number of years to an observatory provided with self-recording instruments is therefore invoked. English officials and merchants abroad do not as a rule display much interest in science, and it is therefore fortunate that the gentleman at present at the head of the Government of Hongkong is one capable of appreciating the great importance of Dr. De La Rue's suggestion and of energetically carrying it out. Governor Hennessy had indeed in some sense anticipated the request, for he had, two years previously, in the first estimates which he prepared for the colony, obtained five thousand dollars from his Council for an observatory and time-ball. He entirely agreed with Dr. De La Rue's remarks, and added that the clearness of the atmosphere at certain seasons would admit of a valuable record being made of sun-spots, while the tides and varying temperature of the seas surrounding Hongkong, and the slight but frequent earthquake phenomena, would also be deserving of the attention of competent observers. A sum of between thirty and forty thousand dollars has been granted altogether for the establishment of an observatory, the chief objects of which are—

1. To determine the local time by astronomical observations, and drop a time-ball daily.
2. To obtain a series of meteorological observations with instruments of the best kinds, and to acquire information relating to the typhoons and monsoons of the China seas.
3. To obtain a series of observations in terrestrial magnetism, also with the best modern apparatus.

In his report Major Palmer addresses himself to each of these subjects separately. He recommends, we are glad to notice, that none but the best instruments should be employed, and that the observatory records should be made and published with scientific precision, and be such as to command public confidence. The meteorological department, he points out, besides furnishing science with valuable data from a locality well suited for the observation and collection of facts appertaining to certain phenomena of special interest, cannot fail to have a direct and practical value by affording security, by its predictions and weather-warnings, to life and property in seas navigated by vast numbers of native and foreign vessels, but subject, during four or five months of the year, to rotatory storms of appalling violence and danger. Its operations, as well as its purpose, would be twofold. There would be the systematic observation and record of the ordinary phenomena of pressure, temperature, humidity, rain, sunshine, wind, and hydrometeors, such as are usual in observatories of the first order, and observations of atmospheric electricity. The second branch would be the observation and collection, as far as possible, of facts and phenomena relating to typhoons, both for the protection of marine interests and for the purpose of contributing bit by bit to our knowledge of a subject at present but little understood. He recommends that measures should be taken to enable the director of the observatory to be placed in prompt telegraphic communication with Manila, Amoy, Shanghai, Saigon, and Singapore, as well as with the south of Japan, and indicates the steps necessary for this purpose.

As for terrestrial magnetism, the character of the rocks and soil of Hongkong, and the neighbouring promontory of Kau-lung, is not, he thinks, the most favourable that could be chosen for magnetic research, yet the position of the colony on the magnetic chart, and with respect to other places where observatories are already established, leaves no room to doubt the value of well-conducted observations.

As to the staff of the observatory, a director, Major Palmer very properly suggests, should be obtained through the Astronomer-Royal, and thinks a salary of not less than 700*l.* a year should be given. Minor officers could be obtained among the non-commissioned officers of the Ordnance Survey Companies of the Royal Engineers. The prime cost he estimates at 6300*l.*, and the

subsequent annual charge at about 2000*l*. It would seem therefore that we may shortly expect to find a tolerably complete and well-equipped observatory in the most eastern of our possessions. It is believed also that, with the assistance of Mr. Hart, the Inspector-General of Chinese Customs, the Government of China may be induced to establish a series of meteorological stations at various points on the seaboard of their vast territory. A perusal of Major Palmer's report leaves on our mind the impression that the Colonial Government is fortunate in being able to obtain at the present time the advice and co-operation of an officer of his ability and scientific attainments.

PROBING BY ELECTRICITY[1]

THE instrument[2] I have the honour of presenting to the Academy has for its object the determination of the exact place occupied by balls of lead, fragments of shell, or metallic substances of any kind embedded in the body of a person wounded by firearms; and it may be considered as a form of the well-known induction-balance of Prof. Hughes.

This exploring instrument enables us to determine that position for the most part with very great exactness, and that without any pain to the patient, which is not the case when we use metallic probes, which require to be brought into direct contact with the projectile.

The instrument is composed essentially of a system of two parallel flat coils partially superposed upon one another in such a manner that the edge of one is nearly over the axis of the other (Fig. 1). One of these coils

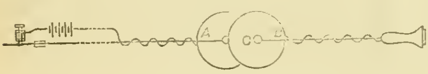


Fig. 1.

(A) is made of thick wire constituting a portion of the primary circuit, and the other (B) of thin wire, constituting a portion of the secondary circuit. Both coils are imbedded in a mass of paraffine placed in the interior of the wooden case furnished with a handle.

A vibratory current from a galvanic battery traverses the primary coil, and the secondary circuit includes an ordinary telephone. Under these circumstances no sound is heard from the telephone; but if we cause any metallic body to approach the part (C) common to the two coils, the silence immediately gives place to a sound the intensity of which will depend upon the nature of the metallic body, upon its form, and upon its distance. We may remark in this connection that the most favourable form that can be assumed by the projectile for which we explore, is that of a flat disk with its face parallel to the surface of the skin, and that the most unfavourable, a similar disk with its face perpendicular to the same surface.

It is difficult in practice to obtain the exact adjustment of the coils required, and it is therefore found advisable to introduce into the primary and secondary circuits respectively two other coils (D and E, Fig. 2) analogous to the first, but very much smaller, whose common surface can be modified by the play of a micrometer screw.

By means of this fine adjustment we are able easily to reduce the telephone to the most complete silence. It should be added that the effects obtained when a condenser (F) is introduced into the primary circuit are much inferior to those obtained without, as had been independently predicted by Prof. Rowland of Johns Hopkins University.

If we wish to ascertain the depth at which the metallic mass lies embedded this is easily ascertained if we know *à priori* its form, its mode of presentation, and its substance. It is only necessary to adjust the apparatus to

Fig. 2.

silence while it is applied to the skin, after which, removing the apparatus, we bring near it another metallic mass similar to that explored for, so as to reproduce silence anew, and the distance of this mass from the exploring instrument gives the measure which it is desired to determine.

I conclude this Note by the relation of an experiment made in the office of Dr. Frank Hamilton of New York, on October 7 last, in the presence of thirteen eminent surgeons.[1] The experiment was made upon the person of Col. B. F. Clayton, wounded in 1862. The ball entered in front through the left clavicular articulation, breaking the clavicle. Doctors Swineborne and Vanderpool supposed that it was lodged under the scapula, but my apparatus demonstrated, on the contrary, that it was located in front and just below the third rib.

MAGNETIC SURVEY OF MISSOURI

IN NATURE, vol. xxiii. p. 583, the writer presented a chart of magnetic declination which represented the results at forty-five stations in Missouri. The facts seemed to indicate a marked effect due to contour. Up to the middle of August of the past summer nothing inconsistent with this explanation was found, although the number of stations had been increased to over eighty. By that time the stations had become so numerous in Central Missouri that a more minute survey along the river bank between Jefferson City and Glasgow gave promise of affording a crucial test. It was necessary that the 8° line, which bends down the river, crossing at some point east of the mouth of the Osage River, should *return* on the south side of the river, looking something like a reversed contour line.

What we did find was, that the 8° line crosses the Missouri Valley *without bending*, running south-west to near the summit of the "divide" between the Osage and Missouri rivers, and *then* bends abruptly to the north-east, re-crossing the Missouri above Jefferson City, and

[1] Upon an Apparatus for Determining without Pain to the Patient the Position of a Projectile of Lead or other Metal in the Human Body. Note by Prof. Alexander Graham Bell, read by M. Antoine Breguet at the Paris Academy of Sciences. Contributed by the Author.

[2] This instrument has originated from researches undertaken in the Volta Laboratory at Washington on the occasion of the sad attempt upon the life of President Garfield. This Note is preliminary to a paper which I shall publish shortly, giving a complete account of these researches. So many different persons have been kind enough to give me the benefit of their suggestions and advice concerning the method of exploration for this object, that I can only mention here the names of a few: Prof. Hughes, George M. Hopkins, Sumner Tainter, Thomas Gleeson, Dr. Chichester A. Bell, Charles E. Buell, Prof. Simon Newcomb, Prof. H. A. Rowland, M. Rogers, Prof. John Trowbridge, J. H. C. Watts, the director of the Western Union Telegraph Company at Washington, and the correspondent of the *New York Tribune* at Washington.

[1] Doctors G. H. Gardner, G. Durant, Ed. Bermingham, N. Bozeman, L. Damainville, J. N. Hinton, Francis Delagield, F. H. Hamilton, D. Chamberlain, Elias Marsh, J. G. Johnson, Joseph Halderson, and J. G. Allan.

after a wide *détour* re-crosses east of Hermann, returning to the south-west, thus forming an immense cape-like area of maximum declination to the east of Jefferson City. It is therefore improper to regard the chart referred to as more than a representation of observations then made, although the stations were more numerous than is usually deemed necessary for an area of 60,000 square miles.

The area of minimum declination represented on the chart of April 21 has been more satisfactorily outlined, and a closed area of maximum declination lying to the west has been determined with certainty.

The work of the past summer has therefore increased the complexity of the isogonic lines, and the *gradual* change in declination in passing through these areas of abnormal value shows that the causes must act over areas of from 1000 to 3000 square miles, *i.e.* that the observed effect is not due to minute local causes at the several stations. It will not be possible to determine fully the extent of these abnormal influences until similar work done in adjoining States shall enable a more precise determination of *normal* values. The stations of observation in Missouri now number over 100. Arrangements for the summer of 1882 have already been made, and the survey will be carried forward on a still more extended scale.

FRANCIS E. NIPHER

St. Louis, October 8

THE ECHINOIDS OF THE "CHALLENGER"

ZOOLOGISTS in general, and echinologists in particular, will welcome vol. iii. part 9 of the "Report on the Scientific Results of the Voyage of H.M.S. *Challenger*," which has just been published. It deals with the Echinoidea, and has been prepared by Prof. A. Agassiz, a more competent reporter than whom it would be difficult, if not impossible, to find. We do not propose to do more than give a brief outline of the principal results brought to light in this portly volume, which runs over some three hundred pages of text, and is illustrated by sixty-five plates.

Commencing with a few remarks on classification, Prof. Agassiz passes on to treat at more length of that vexed question of the position of the axis of the Echinoidea. He dissents from the theory put forward by Lovén in his "Études," a memoir which, however much one may differ from it, cannot be read without a feeling of admiration of the "infinite skill"—to quote Prof. Agassiz's happy expression—displayed by the author. Our reporter again asserts the position he has all along held, that, judging from embryological data, the position of the axis is in the main determined by that of the madreporiform plate. Next in order he deals with the structure of the coronal plates, the anal system, the fascioles, and the structure of the spines. In connection with the latter subject Prof. Agassiz takes exception to some views which we have elsewhere put forward as to the systematic value of acanthological characters. His opinions on any point of Echinoid structure merit the highest respect, and so we do not propose to enter here into an examination of his criticism on our work—a criticism, be it said, which is conceived in the true scientific spirit. A more fitting opportunity will offer itself in a further communication on the subject with which we are at present engaged. The reporter then goes on to notice with extreme aversion the attempts to construct "genealogical trees" "which have become so fashionable." In spite of Prof. Agassiz's well-earned reputation, however, one reads with a sort of shudder the assertion that he is about "to show once for all how futile it must be to carry on" these attempts, especially when we remember the men of mark who engage in them. But a genealogical tree is a upas tree to Prof. Agassiz, and he attacks it with hearty good will, albeit we think that the mathematical axe which he wields is by no means so destructive as he appears to believe. That relations exist between the different groups of Echini no one knows better than Prof. Agassiz, and in the next two or three sections of his Report he shows how well he can use his knowledge in the interesting connections he traces between recent and fossil Urchins, and since this relation does exist we cannot see why the attempt to indicate it graphically or descriptively is to be condemned as futile, even though there may be a minimum of 2^{19} possible combinations of variables. Having passed in review the relations between recent and fossil Echinoids the reporter then comes to what is the real sum and centre of his Report, the description of the species and genera, and here we have an abundance of most interesting matter.

The *Challenger* Expedition has added fifty-two new species, comprised in fifteen new genera, to our list of Echinoids, a very considerable addition when we remember that the order is a comparatively small one. The group which has been most largely increased is that of the Echinothuridæ, of which twelve new species have been described, whilst of the Echinometridæ, Clypeastridæ, and Spatangina only previously known forms have been obtained. It would be of course out of the question to notice all the interesting facts brought to light here; the Report itself must be read for this, and we are fain to content ourselves with a few passing remarks on some of the more striking forms. The remarkable genus Asthenosoma, which was established by Grube in 1867 (Calveria, Wyville Thomson, 1869) to contain an Urchin with a flexible test has been increased by the addition of five new species with a very varied bathymetrical range, one having been obtained at 10 fathoms and another at 1400. Wyville Thomson's genus, Phormosoma (1874), has afforded seven new and most interesting species, inhabiting, as a rule, deeper water than its companion genus (255 fathoms to 2600 fathoms). To this genus belongs the honour of furnishing the largest Urchin which Prof. Agassiz has hitherto met with, *Ph. hoplacantha*, Wy. Thoms., measuring 312 mm. in diameter—truly a good-sized specimen. Amongst the Didematidæ we have a remarkable new genus, Aspedodiadema, with the abactinal system and ambulacral plates of a Cidarid combined with the thin test and hollow spines of a Diadema. Micropyga is another hitherto undescribed genus of the same family. Passing over the Echinometridæ (no new species), the Temnopleuridæ (three new species), the Triplechinidæ (one new species), and the Clypeastridæ (no new species), we notice amongst the Petalosticha thirteen new species of the curious genus Pourtalesia (A. Agass., 1869) with its remarkable beaked test; and, amongst other new genera, Cystechinus, which appears to be related to the fossil genera Galerites and Ananchytes. We might go on for a long time noting one interesting form after another, were it not that to do so would make this notice inordinately long. How far further study and discovery will affect the number of genera and species enumerated here it is impossible to say, but as Prof. Agassiz is by no means given to multiplying species, and as most of the specimens appear to have been well preserved—only a few having been described from fragments—it is likely that the greater number will stand. A word in conclusion as to the plates. The majority of them have been drawn by Mr. Roetter, and we congratulate Prof. Agassiz on having at his disposal the services of so gifted a draughtsman. Many of the plates are to our mind very gems of lithographic art. The drawings of the sections of spines, though very pretty, and in most instances handled with great delicacy and finish, do not always give the clearness of detail that could be desired, and the mechanical arrangement both of these plates and of those containing the pedicellariæ and the side views of spines is decidedly objectionable. It may be that Prof. Agassiz and his

artist have constructed some subtle key whereby they can discover at once the position of any required figure, but it is hidden to our clumsier intellect; and when a plate contains from thirty to fifty-nine figures, numbered apparently without any definite order, the task of picking out any given figure becomes rather tedious. Having said this, however, we have said all that we think we can say against the beautiful plates which accompany Prof. Agassiz' most interesting "Report on the Echinoidea of the *Challenger*." H. W. MACKINTOSH

NOTES

THE anniversary meeting of the Royal Society will be held, as usual, on St. Andrew's Day, the 30th inst. The following is the list of the Council and Officers nominated for election:—President, William Spottiswoode, M.A., D.C.L., LL.D.; Treasurer, John Evans, D.C.L., LL.D.; Secretaries, Prof. George Gabriel Stokes, M.A., D.C.L., LL.D., Prof. Michael Foster, M.A., M.D.; Foreign Secretary, Prof. Alexander William Williamson, Ph.D.; other members of the Council, Francis Maitland Balfour, M.A., I. Lowthian Bell, F.C.S., Sir Risdon Bennett, M.D., Prof. Thomas George Bonney, M.A., Prof. Heinrich Debus, Ph.D., Alexander John Ellis, B.A., Sir John Hawkshaw, M.I.C.E., Thomas Archer Hirst, Ph.D., William Huggins, D.C.L., LL.D., Prof. Thomas Henry Huxley, LL.D., Prof. Joseph Lister, M.D., Prof. Daniel Oliver, F.L.S., Prof. Henry Enfield Roscoe, B.A., LL.D., Warington W. Smyth, M.A., Henry Tibbats Stainton, F.G.S., Edward James Stone, M.A. Prof. Huxley having retired from his office as one of the secretaries, as we intimated last week, Dr. Michael Foster has been named in his stead.

THE Treasury has, it is stated, awarded the late Astronomer-Royal, Sir George Airy, a pension of 1100*l*. per annum, in consideration of his long and valuable services.

MOST of our readers will have heard with regret, and probably surprise, that Prof. Ferrier has been charged with a breach of the Vivisection Act. On the general question our opinion is well known, but into the merits of this particular case we cannot enter so long as the trial is pending.

THE Queen has conferred the honour of Knighthood upon Mr. Erasmus Wilson, President of the Royal College of Surgeons.

THE death is announced of Dr. Bouillaud, the *doyen* of medical science in France, and Member of the Academy of Medicine and Academy of Sciences. He was born at Angoulême in 1796.

THE impending change in the French Cabinet has brought forth an unusual number of regulations from the Minister for Public Instruction. Two of the more notable are the creation at Limoges of a Government school for industrial arts and a general reorganisation of the veterinary schools of Alfort (near Paris), Lyons, and Angoulême.

M. KELLER, who is a Member of the French Senate, has met with an accident in his laboratory. His hand has been severely burnt by an explosion, and he will probably not be able to resume work for a month.

THE experiments at the Paris Opera with the electric light have been successful so far as concerns incandescent light, which is now regularly used. A final decision on the matter will be come to very shortly.

OUR Paris Correspondent writes that the success of the Siemens Electrical Railway has been so great that the Municipal Commission appointed to report on the possible application of electricity will advise the experiment of an elevated railway in some part of Paris. The only objection to the erection of such a line on the Boulevards is its aspect, which it is supposed will not be sufficiently ornamental. A large number of practical suggestions will be made by this Commission.

THE Russian Government has made a grant of 14,000 roubles for next year for two Polar observing stations:—One at the mouth of the Lena, and the other, of second rank, but also for meteorological and magnetic observations, on one of the islands of New Siberia.

THE Corporation of Chesterfield deserves credit for their enterprise; they have decided to dispense with gas entirely as far as public lighting is concerned, and to replace it with the electric light. The lighting will be done by means of about twenty-two Brush "arc" lamps and about seventy Lane-Fox incandescent lamps. Doubtless the example of Chesterfield will soon be followed by other towns.

THE Council of the Society of Arts, on the recommendation of the judges in the late competition of plant labels, are prepared to renew the offer of a Society's silver medal, together with a prize of 5*l*., which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants. The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award. Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the secretary of the Society not later than May 1 1882.

THE Royal Commission on Technical Instruction, presided over by Mr. Samuelson, M.P., has begun its work in Paris by visiting the École d'Apprentis in the Boulevard de la Villette, the École d'Horlogerie in the Faubourg du Temple, and those communal schools in which handicrafts are taught. After inspecting the secondary and higher technical schools of Paris the Commissioners will proceed to Chalons, Lyons, Rouen, and some manufacturing towns in the North of France.

AT the ordinary meeting of the Council of the Sanitary Assurance Association, held at the offices, 5, Argyll Place, Regent Street, on Wednesday, October 26, Prof. Hayter Lewis, F.S.A., in the chair, certificates were issued under the Corporate Seal of the Association to those subscribers who had carried out the recommendations of the Association with regard to the sanitary arrangements of their houses. These certificates, which are as yet a new feature in connection with provident householding, are not of less importance than Fire Insurance polices. The certificates are signed by the chief sanitary officer of the Association, Prof. Corfield, M.D., and the surveyor, Mr. Mark H. Judge, and they guarantee the satisfactory condition of the houses to which they refer; the inspection, report, and supervision of the work, where alterations are necessary, being made personally by both officers. The certificates are issued subject to an annual inspection of the property, for which the members are charged a small fee, according to the rateable value of the houses; for instance, for a house rated at 80*l*. the fee is half-a-guinea for each annual inspection, while for a house rated at 200*l*. the fee is two guineas. Detailed reports of works in progress were made, and correspondence thanking the Council for the thoroughness of the reports and supervision of work was read. It is just twelve months since the first meeting of the Association was convened, under the presidency of Sir Joseph Fayrer, K.C.S.I., to form an organisation which should apply the combined sanitary knowledge and experience of medical men, architects, and others by means of specially qualified officers who should yearly inspect the houses of members and report upon their drainage, water supply, and ventilation. The Association was soon after incorporated by special licence of the Board of Trade, by which it is bound to apply the whole of the income and property of the Association solely towards the promotion of its objects, and no dividend or profit can be paid directly or indirectly to the members. The work of the Associa-

tion is very simple in plan. Application is made for the inspection of a house, and the inspection is made personally by both the chief sanitary officer and the surveyor, who supply a detailed report on the sanitary condition of the property, together with a specification of the work necessary to put it into a condition satisfactory to the Association. While this work is in progress it is supervised by these officers, and on its completion the Council grant a certificate guaranteeing the sanitary condition of the property, subject to an annual inspection by the officers of the Association.

AT an examination held by the Sanitary Institute of Great Britain on November 3 and 4, eight candidates presented themselves, and the Institute's Certificate of Competency as Local Surveyor was not awarded, but the Institute's Certificate of Competency as Inspector of Nuisances was awarded to J. Horrocks, W. Sortwell, and J. W. Witts.

THE Linnean Society of New South Wales has had the enterprise to organise a course of lectures on zoology, open to all who care to take advantage of them. They begin on October 4, and are to extend to December 9, about two lectures being given each week. The lecturer is Mr. W. A. Haswell, M.A., B.Sc.

IT is announced, we learn from the *Lancet*, that the three volumes of the *Transactions* of the International Medical Congress will be published and ready for distribution at the beginning of December. To non-members the price of the work will be 30*s*., and the volumes can each be bought separately. The first volume will contain the list of members, accounts of the general meetings, the general addresses, the description of the specimens exhibited in the museum, and the transactions of the sections of anatomy, physiology, pathology, and materia medica and pharmacology. Volume II. will contain the transactions of the sections of medicine, surgery, State medicine, military medicine and surgery, obstetric medicine and surgery, and diseases of children. Volume III. will contain similarly the transactions of the sections of ophthalmology, mental diseases, diseases of the skin, diseases of the throat, diseases of the ear, and diseases of the teeth. Orders for the work will be received by J. W. Kolckmann of Langham Place.

BULLETIN No. 6 of the United States Entomological Commission consists of a General Index and Supplement to the nine Reports on the Insects of Missouri, by Prof. C. V. Riley, forming in itself a volume of 177 pages. It is very complete. All the descriptions of new species described in the Reports are reproduced, with such alterations indicated as time may have rendered necessary. It is carefully analytical, and one heading will strike many as introducing a comparatively new term, *i.e.* the "List of descriptions of the *adolescent* states."

WE have already referred to the Smithsonian Report for 1879. Mr. O. J. Mason's bibliography of Anthropological Investigations, which appears in the Report, has been separately reprinted, and will be found useful by those interested in the subject.

DR. OTTO FINSCH, whose scientific journey in Polynesia we have repeatedly referred to, arrived at Wellington, New Zealand, in June last, and now intends returning soon *viâ* Sydney.

THE additions to the Zoological Society's Gardens during the past week include a Tiger (*Felis tigris* ♀) from Assam, presented by Col. Owen Williams, M.P., F.Z.S.; a Black Bear (*Ursus americanus*) from North America, presented by Capt. McPherson, barque *Ocean Nymph*; two Common Polecats (*Mustela putorius*) from France, presented by M. P. Pichot; a Young Ostrich (*Struthio camelus*) from Africa, presented by Mr. William Jewram; a Great Eagle Owl (*Bubo maximus*), European, deposited; three Common Curlews (*Numenius arquata*), two Red-throated Divers (*Colymbus septentrionalis*), European, received on approval.

OUR ASTRONOMICAL COLUMN

DOUBLE-STARS.—An important series of observations of double-stars has been recently issued from the United States Naval Observatory at Washington. It includes all the measures made by Prof. Hall with the 26-inch refractor from 1875 to 1880, and a few in the year 1863 with the 9·6-inch equatorial. There are observations of double-stars selected by M. Otto Struve for the comparison of micrometrical measurements by different astronomers, which remain for discussion when those of other observers are published. In addition, in order to apply a geometrical test to the observations, Prof. Hall has carefully measured the multiple stars Σ 2703 and 311, and the stars in the trapezium of Orion. The observations have been made with the filar-micrometer by A. Clark and Sons, which is commonly used with the large equatorial. Then follow measures of objects chiefly taken from the catalogues of the Struves, with a few others mostly discovered by Mr. Burnham. Σ 2 was not separated with power 888 in 1879. Of γ^2 Andromedæ we find the angle 101°·0 distance 0″·358 for 1878·21; 40 Eridani (B.C.), 125°·0, 3″·515 for 1879·18. A great change is shown in O.Σ. 82; we have 230°·8, 1″·08 for 1848·67, while Prof. Hall's measures give 182°·25, 0″·765 for 1879·16. Mr. Marth's faint companion of Sirius, estimated 13m., was at 114°·9, 71″·4, at the epoch 1847·47, which, compared with the particulars at p. 38 of *Memoirs* R.A.S., vol. 36, indicates fixity. Prof. Hall remarks on the supposed companions of Procyon, "I have never been able to see any of these companions that would stand the test of sliding and changing the eyepiece, turning the micrometer, &c., and am therefore doubtful of their existence. This is an interesting star for the powerful telescopes of the future." Six nights' measures of 25 Canum Venat. give 157°·5, 0″·507 for 1879·49; Dr. Doberck has calculated elements for this star, period 124½ years. γ Coronæ Borealis was single in 1875-76 and 1879. 72 Ophiuchi was examined in 1876 and 1879, but no close companion was visible: it may be remembered that at the epoch 1859·61 Secchi saw and measured the close star, and recorded it as "*bene separata*," and Otto Struve has measures of it in 1842, 1847, 1851, and 1876, those in the latter year corresponding almost precisely to the date of the Washington examinations, which seems to point to optical illusion, unless rapid variability is admitted. At the epoch 1879·77 δ Equulei was thought to be elongated at 150°, but Prof. Hall was not certain of its duplicity. Many of the more interesting binaries are included in this series of measures. The observations of the companion of Sirius made at Washington from 1866 to 1879 are given in a collective form, and we have observations of the faint stars near the annular nebula in Lyra, of which the following results possess value; *a* is the brightest of these stars and the one near the following end of the nebula; the angles and distances are referred to it except in the case of the companion of the triple star *f*, which are referred to *f* itself:—

		Pos.	Dist.	Magnitudes.
		°	″	
a and *b*	1877·582	225·50	93·90	10 and 14
a ,, *c*	1877·582	268·00	115·84	10 ,, 13–14
a ,, *d*	1877·592	286·90	138·58	10 ,, 12–13
a ,, *e*	1877·592	292·60	122·90	10 ,, 12
a ,, *f*	1877·582	313·70	101·79	10 ,, 13–14
a ,, *g*	1877·592	350·60	77·18	10 ,, 13
f ,, f_1	1877·592	253·30	3·96	13–14 ,, 13–14
f ,, f_2	1877·592	4·80	17·32	13–14 ,, 14–15

To connect the nebula with the stars the following estimates were made:—

(1) The right line *a* to *b* is 11″ outside of the nebula.
(2) ,, ,, *a* ,, *c* very nearly bisects the darker, interior part of the nebula.
(3) ,, ,, *a* ,, *f* is very nearly tangent to the nebula.
(4) ,, ,, *b* ,, *c* is nearly tangent to the nebula.

It is added that during these observations no star was seen inside the above ring of stars, nor any star within the nebula itself. Afterwards it was thought that a star was seen within the nebula, but Prof. Hall was not able to measure it.

GEOGRAPHICAL NOTES

THE twenty-third and twenty-fourth parts of the *Mittheilungen der deutschen Gesellschaft für Natur und Völkerkunde Ostasiens* contain an article by Dr. L. Döderlein on Oshima, one of the

largest of the chain of islands which runs from the south coast of Japan to the east coast of Formosa, and which include the Loochooan archipelago. The island has never before been visited by a European, and presents many features of scientific and general interest. Dr. Döderlein spent sixteen days there, during six of which he was kept indoors and in darkness by a violent typhoon, which is described in the twenty-third number of the *Transactions* of the same Society by Mr. Knipping of Tokio. Two distinct types of people were found in the island, one pure Japanese, the other—probably the original inhabitants before the Japanese conquest—are about the same size as Japanese, but somewhat better built. The face is not so broad, and grows smaller towards the bottom, so that the chin is pointed, a feature rarely found in the Japanese, whose chins are broad and round. The lips and nose are thin, the bridge of the latter being convex. The eyes are large like those of the people of Southern Europe. The most striking portion of the appearance of this people, however, is the thick hair which they have all over their bodies. In this respect they closely resemble the Ainos of Yezo and Saghalin. The language, of which some examples are given, is evidently a dialect of Japanese, half-way between the latter and Loochooan. The customs are in many respects different from those of Japan. The women tatoo themselves on the backs of the hands (the Aino women, it will be remembered, tatoo the lips) from the wrists to the roots of the nails. The marks are always the same, but no explanation of the custom could be given by the people. When a girl reaches the age of thirteen the operation is performed on her hands by people specially trained for the purpose. Married women never blacken the teeth, as in Japan. Although the population is about 50,000, there is neither priest nor temple in the island, and the people know nothing of a deity to whom they should pray. They pay a sort of veneration to their ancestors, but only to individuals, not to the progenitors of their race or tribe, as in Japan. Life would run very smoothly with the people, were it not for a poisonous snake, called *habu*, belonging to the Trimeresurus class. It attains a length of six or seven feet, and is equal in venom to the most poisonous snakes. The Japanese fear to land on the island on account of these reptiles, which are found everywhere. They are said to pursue eels in the streams, to climb trees easily, and even to do so for the purpose of attacking travellers more easily. At night no one will stir abroad, for the bite is invariably fatal unless assistance is immediately procured. In one place a village of thirty-one houses was abandoned because the *habu* were numerous in the neighbourhood. The only cure employed is excision of the part, or even of the limb, which has been bitten. The general conclusion at which Dr. Döderlein arrives is that Oshima belongs in its *fauna* to the Loochoos, and has but little connection in this respect with Japan. He thinks, therefore, that the boundary between two great zoological regions, the paleoarctic and the oriental, lies between the island and Japan.

In the last number of the *Proceedings* of the Berlin Geographical Society Dr. G. Fritsch has an extremely suggestive paper on geography and anthropology as mutual helpmates. The writer dwells upon the great aid each of these studies might derive from the sister science, if conducted in a broad and enlightened spirit. There are problems connected with the evolution of man and with his present distribution over the earth's surface, the solution of which depends upon a more exact knowledge of the former distribution of land and water, especially in the Tertiary period. The gap that separates man from any of the living anthropoids is profound; but it may possibly be bridged over or contracted to smaller proportions by the future discovery of fossil remains in the tropical regions, where the race most probably originated. Should these regions fail ultimately to yield the connecting links, then the conclusion would be strengthened that the evolution of mankind took place in some now submerged land, as, for instance, in the Lemuria of the Indian Ocean, or in the vast continent of which the Pacific islands may be regarded as the fragmentary remains. In the latter case the problem would remain practically insoluble, and the descent of men from some now extinct anthropoid forms would have to be regarded as at most an assumption incapable of strict demonstration. The present distribution of mankind, the writer goes on to point out, is largely bound up with more partial modifications of the earth's surface. A good instance is the Dravidian or aboriginal race of the Deccan, differentiated from the other types of the Asiatic mainland during the period that Southern India was still a triangular insular mass, before the now connecting Northern plains were created by the alluvia of the Indus and Ganges. From considerations of this sort Dr. Fritsch suggests a scheme of fundamental human types differing in some respects from any hitherto proposed by anthropologists, and insists especially on the necessity of separating the Koi-Koin (Hottentots and Bushmen) from the Negro proper. He also argues on similar grounds for the unity of the "homo Americanus," whom he refuses to regard as a mere branch of the Mongol or any other type of the Old World.

In a letter from Landana Père Carrie announces the arrival of Père Augouard's Stanley Pool expedition at Isangila on July 12. They were to resume their march for Manyanga on July 14, and hoped to reach it in eight days. Mr. Stanley is said to be hurrying on with his work in view of the expiry of his engagement with the International Association in March next.

The chance of obtaining news of the missing *Jeannette* exploring expedition before the winter closes in appears to be getting very remote. The revenue cutter *Thomas Corwin* has returned to San Francisco, and the steamer *Alliance* to Halifax, N.S., without any intelligence whatever of the party, and now we hear that the visit of the *Rodgers* to Wrangel Land has also been without result. Small boats belonging to the *Rodgers* circumnavigated Wrangel Land. The party in the boats also surveyed different parts of the island. The views from the top of the mountain on Wrangel Land disclosed sea all around it. The season had been most favourable for the purposes of exploration, owing to the openness of the navigation. The *Rodgers* would probably take up her winter quarters at St. Lawrence Bay, whence she expected to sail in June next, and proceed as far north as possible. Lieut. Berry finds that Wrangel Land is an island sixty miles in length.

The November number of *Petermann's Mittheilungen* is mostly occupied with two papers—On the Water-ways of France, by H. Keller; and on the Marsh Region of the Equatorial Nile System and its Grass Barriers. The latter is a paper of great value and interest, giving the results of the writer's observations during his recent terrible Nile journey. It is accompanied by a map of part of the Bahr el Abiad and Bahr el Seraf. There is also in the number a summary of the proceedings of the recent Venice Congress.

The Geographical Society at Bremen has received a telegram from the Brothers Krause, dated the 6th inst., announcing their safe arrival at San Francisco with good scientific and ethnographic collections. These explorers had visited the Chukchi Peninsula at various points, and intended spending the winter in the north of Alaska.

SCIENCE IN NEW SOUTH WALES

A GOODLY record of scientific work is furnished from time to time by our vigorous colonies on the Australian continent, where (as in other young countries), if the aids to science are not so complete as in some parts of Europe, the incitements to philosophical observation of natural phenomena are, for obvious reasons, peculiarly strong.

The *Journal and Proceedings* of the Royal Society of New South Wales for 1880, recently received by us, includes, with other matter, many valuable observations adding to a knowledge of the country. We gather that within the last quarter of a century, from natural decay, ring-barking, and clearing for cultivation, at least one half of the timbered land of the colony (it is estimated) has been denuded of trees. A very considerable diminution of rainfall might perhaps have been expected in consequence, but this has certainly not been the case; indeed statistics rather indicate the reverse. The principal rivers, too, have not been diminished in volume of water. Instructive in this connection is the experience of Mr. Abbott, with ring-barking of trees on his run at Glengarry. This operation (for improvement of grazing capacity) he carried out in 1869 and 1870, on most of the watershed of three creeks, each about two miles long, draining well-defined valleys shut in by high ridges of basalt. For twenty years previously these creeks were dry watercourses, only holding water for a few days after rain, and in a few places in winter. But soon after ring-barking they became, and have continued, permanent streams, with increased flow of water and number of springs. The explanation Mr. Abbott offers is that the large proportion of the rainfall formerly taken up by the gum-trees and evaporated, now finds its way to the creeks and rivers.

The records of thunder and hailstorms in New South Wales up to the end of 1878 were examined by Mr. H. C. Russell, with reference to the risk from hail to the Exhibition Building erected in 1879. The list is given in this volume. Mr. Russell could not trace any period in those storms, except that they seemed more numerous in the first year after a drought. They are not severe or numerous in wet years. The great number of storms when the earth is passing through the November meteor stream is noted.

The so-called salt-bushes of Australia are known to have properties that are of great advantage to sheep, which relish and fatten on the food, especially in times of drought. Mr. Dixon has analysed some eight of those fodders of the Riverina district, and shows, by comparison with well-known European fodders, that they stand well as to nutritive value. One is struck with the extraordinary amount of ash. In seven of the eight, the average ratios of total ash, potash, and common salt to digestible matter (oil, carbohydrates, and albuminoids), taken as 100, are 47, 9·538 and 7·689 respectively; and the difference here from European fodders is conspicuous. Cotton bush (the eighth examined) ranks with the latter. Only two contain a very large proportion of common salt, viz. oldman salt bush (the most prized by graziers), has 15·403, in the relation just specified, and small salt bush, 14·590. While digestion is doubtless promoted by the soluble chlorides, it is in the wool that the greatest effect of the diet (so rich in potash) might be expected, and the high esteem in which Riverina wool is held, is a verification of this.

Various kinds of coal of New South Wales have been subjected to analysis by Mr. Dixon and by Prof. Liversidge, the latter of whom specially wished to see how they compared with our coals. He found the Northern District coals to contain least ash, average percentage 4·61; those of the Western District have 10·44 per cent.; and those of the Southern 10·99. Thus some of the Northern coal is quite equal in this respect to the Welsh and Scotch coals, and but little inferior to the English Newcastle coal. The quantity of sulphur in New South Wales coal is by no means excessive. Prof. Liversidge also furnishes an account of some minerals from New Caledonia, including the nickel-bearing *Noumeaite*. This mineral seems to be completely amorphous; the mass splits up into smooth concave-convex pieces like petals of an unopened bud. It is in some cases soft and brittle, and in others hard and tough enough to be cut into ornaments. The colour varies from the palest tinge of green to full rich malachite green. The composition ranges from practically pure hydrated silicate of magnesia to what is also practically only hydrated silicate of nickel. The earthy cobalt ore (asbolite) from New Caledonia differs considerably from those met with in other places; baryta is entirely absent, but magnesia seems to have taken its place in some cases.

An interesting paper by Dr. Manning, medical superintendent of the Hospital of the Insane at Gladesville, treats of the causes of insanity in 3077 patients admitted to that institution in ten years from 1869; a comparison being also drawn with English statistics. We note that 3·9 per cent. of the cases of insanity are attributed to isolation and nostalgia conjointly (a category not given in the English table). The cases of pure nostalgia were those of foreigners, who spoke English most imperfectly. The cases of isolation included shepherds, whose occupation some years ago was most lonely, and still is, in some places, though the state of things is improving in this respect. Dr. Manning found last year that more than one half (1038 out of 2036) of the inmates of those institutions in the colony were apparently quite friendless, and that 10 per cent. were foreigners. The isolation, which is something terrible to a new emigrant, and which lasts often for years, is kept up by the disparity of the sexes, which at the close of 1879 stood at 409,665 males and 324,617 females, and it is fostered by the peculiar shifting and restless life of the miners and the bushmen. Dr. Manning thinks the insanity from intemperance has been exaggerated; the percentage at Gladesville is 8·3. The vile quality of the drink (he considers) and the system of drinking (short reckless outbursts, with prolonged periods of abstinence), are prominent factors in the result. Sunstroke, as might be supposed, causes insanity to a much greater extent in New South Wales than in England; 5 per cent. of the cases are accredited to it. Dr. Manning also expresses the opinion that insanity through lactation prolonged beyond the ordinary time is more frequent. Again, he is struck with the number of cases admitted with symptoms of dyspepsia and "chronic ill health," and he attributes a considerable number of those to the want of varied and properly cooked meals. As to hereditary transmission of insanity, the Gladesville statistics give only 7·2 per cent., but they are much less complete than the English, owing to the difficulty of getting to know the family history.

We can do no more than briefly indicate some of the other subjects dealt with in this volume; some new double stars, the longitude of Sydney Observatory, the opposition and magnitudes of Uranus and Jupiter, the orbit elements of Comet I. 1880, changes in the surface of Jupiter, catalogue of plants collected by Forrest in North-West Australia, fossil flora of Eastern Australia and Tasmania, piturie, iron acted on by seawater, wood inclosed in basalt, fossils from Palæozoic rocks of New South Wales, schemes of water supply for Sydney, wells in the Liverpool plains.

ON THE APPLICATION OF PHOTOMETRY IN THE STUDY OF THE PHENOMENA OF DIFFUSION IN LIQUIDS

§ 1. SINCE the publication in 1803 of Berthollet's work,[1] in which it is already asserted that the diffusion of salt solutions in water takes place according to the same laws as the propagation of heat in solids, an exact method has frequently been sought for determining the coefficient of diffusion. The attempts in this direction have failed to give concordant results, which may best be judged from a compilation of the numbers expressible in absolute units with reference to chloride of sodium, whose coefficient of diffusion in water has most frequently been measured. The coefficient is stated to be—

By Graham, at 5° C.	88	$\times 10^{-7} \cdot \frac{cm^2}{sec.}$
,, 9° C.	105	
By Fick	116	
By Johannisjanz	53	
By Schuhmeister, at 10° C.	97	

When we inquire into the laws which govern this coefficient we meet with even greater discrepancies. Thus Graham, Fick, and Schuhmeister's researches indicate the increase of the coefficient with the rise of temperature. Johannisjanz finds no such relationship. Thus H. F. Weber, experimenting with sulphate of zinc, concludes that the coefficient of diffusion decreases with increase of concentration. Schuhmeister asserts exactly the contrary.

The importance which diffusion has gained of late as a means of investigating and solving many problems connected with molecular physics[2] induced me to search for a method which should permit me to investigate the processes of diffusion, not alone with more accuracy than heretofore in that direction in which the final results may be ascertained by simple weighing, but also to open up a new field of research which has been inaccessible up to now for want of suitable methods. A detailed description of my method, and a full account of all the circumstances to be observed in carrying out the experiments, will be found in *Wiedemann's Annalen*, vol. xiii. pp. 606–23. I will only give here the general outlines.

In the middle of a large glass trough a glass dish is inverted. On the top of this dish a narrow but thick glass rod is placed horizontally, and upon this four cylindrical vessels of approximately equal height at suitable distances from each other and from the walls of the trough. These are filled with solutions of the salt to be investigated, in such a way that the meniscus attains its maximum height. Water is now poured into the trough till it reaches in height 0·1 cm. below the edge of the shortest cylinder, and the whole allowed to stand for several hours to equalise the temperature. After this, by means of a specially constructed funnel, more water of exactly the same temperature as the water in the trough is introduced, until it reaches a height of several millimetres above the edge of the cylinders.

The apparatus is now left to itself.

To interrupt the experiment a method has been devised, the description of which will also be found in *Wiedemann's Annalen*.

The result is calculated by the formula—

$$D = \frac{l^2 \pi}{4} \left(1 - \frac{c_2}{c_1} \right)^2 \cdot \frac{1}{t},$$

[1] Berthollet, "Essai de statique chimique," Paris, 1803, vol. i., pp. 409–429.

[2] See Wroblewski, "On the Nature of the Absorption of Gases," in NATURE, vol. xxi. p. 190.

where signify]

l the depth of the cylinder.

t the time of the experiment.

c_1 the concentration of the salt solution before the experiment.

c_2 the mean concentration of the solution after the experiment.

D the coefficient of diffusion.

§ 2.—Chloride of sodium was the substance experimented with to test the method. Three solutions were prepared, of which the first contained 0·66487, the second 5·8506, and the third 17·695 parts by weight of the anhydrous salt in 100 parts of the solution. The cylinders employed were 2 to 8 cm. in diameter, and 3·45 to 5·036 cm. in depth. The experiments were conducted either in such a way that all the cylinders were filled with the same solution, and the observation made if the cross-cut and the depth of the cylinder had influenced the final result; or else differently concentrated solutions were taken, and the experiment carried out at exactly the same temperature and under the same other conditions. The method was found to be sensitive and accurate. The temperature being 8·5° C., and the duration of the experiment 6·5 hours, the coefficient found was:—

$$\left.\begin{array}{lll}\text{With a solution of } 0{\cdot}66487 \text{ per cent.} & \ldots & 768 \\ \quad ,, \quad ,, \quad 5{\cdot}8506 \quad ,, & \ldots & 808 \\ \quad ,, \quad ,, \quad 17{\cdot}695 \quad ,, & \ldots & 889\end{array}\right\} \times 10^{-8} \frac{\text{cm}^2}{\text{sec.}}$$

The conclusion to be drawn from these numbers is that coefficient of diffusion within the limits of time and concentration indicated decreases according to the law of the straight line as the quantity of salt in solution.

From this result follow:—

1. The numerical value of the coefficient at the same temperature, and the same initial concentration depends upon the duration of the experiment.

2. A fixed state, in which the concentrations in the fluid decrease from bottom to top, according to the law of the straight line, is impossible. Fick's method, which presupposes this state, cannot therefore give correct results.

From the above-mentioned law of the dependence of the coefficient of diffusion on the quantity of salt in solution, and from the first conclusion, it follows that at one and the same tempera ture the value of the coefficient may vary between two widely separated limits. An experiment performed with a saturated solution during the shortest possible time would furnish the one limit, another with a solution containing a quantity of salt approximating to zero would give the other.

The physical cause and the necessity for the mentioned dependence is very simple. If a volume of water be mixed with one volume of concentrated salt-solution, and if a volume of water be mixed with a volume of dilute salt-solution, the resulting contraction in the first instance is greater than in the second. The diffusion of a salt-solution in water has been up to the present considered from a very one-sided point of view. Berthollet and Fick ascribe the diffusion to the forces alone which act between water and salt-solution; modern investigators ascribe it solely to the molecular velocity of the fluid molecules. The experiment shows that the diffusion depends on both, and therefore supports neither of these views entirely. When the cylinder has been filled with concentrated solution the participation of the molecular forces is greater than in the case of weak solution. The numerical value of the coefficient of diffusion, which expresses the result of the experiment, must necessarily be greater in the first case than in the latter. It is therefore in our power to regulate the phenomena of diffusion in a salt solution according to our will; thus when we experiment with concentrated solutions the principal agents at work are the molecular forces, whilst the velocity of the molecules plays the chief part in dilute solutions. The coefficient of diffusion of a salt-solution loses, therefore, entirely the signification of a constant, because in every special case it has another value.

§ 3. The coefficients of diffusion of salt solutions in water at the temperature of 10° C., determined by Graham, Fick, Weber, and Schuhmeister, form a group of numbers which lie between 0·000010 and 0·000002 $\frac{\text{cm}^2}{\text{sec.}}$.

It was of great interest to ascertain the value of the coefficient of diffusion when the quantity of salt is so small that it can neither be estimated with the balance nor with chemical means; when, in short, the solution differs hardly at all from pure water, and when the participation of molecular forces has been brought to a minimum. Such an experiment may be made by tinting water with a salt of great tinctorial power and observing the diffusion of the coloured water into the pure. It is much more difficult to follow these experiments quantitatively, as very small quantities have to be determined. Colorimetrical methods are not sensitive enough.

I therefore tried to measure the concentration photometrically. Nigrosin, which is sufficiently stable towards sunlight, was the colouring matter chosen for the purpose. Hüfner's spectro-photometer was employed. The water was coloured with nigrosin to such an extent that its coefficient of extinction for sodium light amounted to 1·343. The quantity of colouring matter used was so small that the change of specific gravity in the water through its addition could not be ascertained.

A full report of the many difficulties which were encountered and a detailed description of how the experiments were conducted will be found in the above-mentioned *Wiedemann's Annalen*. It was discovered that the coefficient of diffusion was smaller by one decimal place than the smallest known coefficient of a salt.

The method here described urges the investigation of a series of new problems.

In the first place the value of the coefficient must be ascertained for different salts when the salt in solution approximates zero. When these values have been found, only then it will be possible to define in what way the coefficient of diffusion depends on the nature of the salt.

Secondly, it is necessary to find out if it is not possible, by tinting water with different colouring-matters, to obtain a constant, which I propose—analogously to a case already considered by J. Clerk Maxwell—to call *the coefficient of diffusion of a fluid into itself.*

If we suppose a room to be divided into two parts by a movable wall and filled with the same gas at the same pressure and temperature, and we then remove the wall, a diffusion of the gas takes place from the one half of the room to the other, and *vice versâ*, in consequence of molecular velocity. The coefficient of the diffusion which takes place here, Maxwell calls *the coefficient of diffusion of a gas into itself.* It is not measurable, as the molecules of a gas cannot be marked. It can however be calculated from the coefficient of viscosity of this particular gas kinematically measured by multiplying by 1·5435.

When salt-solution diffuses, it is not the salt, but the salt-solution, which diffuses into water. The more dilute the solution, the nearer that state is approached in which pure water diffuses into pure water. How near I have approached this state in my experiments with nigrosin I have no means at present to judge. I have no doubt however that this is the only method of ascertaining the coefficient, which, if once determined in similar manner for every fluid, will be of eminent importance to a kinetic theory of fluids, which has yet to be built up. It is only necessary to bear in mind the assistance rendered to Maxwell by the determination of the coefficients of diffusion of gases by Loschmidt.

S. WROBLEWSKI

THE ROTATIONAL CO-EFFICIENT IN VARIOUS METALS

THE following is an abstract of a Note on the above subject read by Prof. E. H. Hall at the meeting of the British Association at York.

It was discovered two years ago in Johns Hopkins University that when a conductor carrying a current is placed in a magnetic field, the direction of whose force is perpendicular to the current, the current is deflected at right angles to the force and to the original direction of the current. A slip of gold leaf on glass was placed between the poles of Faraday's electro-magnet, with the faces of the gold-leaf perpendicular to the lines of force. Wires were attached one at each end of the strip, for the purpose of transmitting a current through it, and two other wires were led from the middle points of the sides of the strip to a Thomson's galvanometer. When the electro-magnet was not made this galvanometer showed no deflection, but on sending a current through the coil of the electro-magnet a deflection was obtained, and on reversing the direction of this current the deflection was reversed.

Dr. Hopkinson has pointed out that Maxwell, in the first part of his book, treating this subject in the most general way, allows the possibility that something of this kind may take place. Maxwell suggests the name "rotational coefficient"; so the

term which I employ is his, though the fact was not known to him.

I have published an article describing these experiments, which may be known to you, but I have since found some new facts. At Berlin I tested some metals which I had not tried before. I cannot vouch for the quantities within 50 per cent., but I think I can vouch for the direction of the effect. It is not the same for different metals under the same conditions of current and magnetic force. It might have been expected that the effect would be in the same direction in nickel as in iron; but it is not, it is in the opposite direction; nickel acts like gold, cobalt acts like iron. Nickel, silver, gold, platinum, and tin gave an effect opposite to iron.

The most important fact that I have to bring before you is that in zinc the effect is in the same direction as in iron and cobalt.

Table of effects on an arbitrary scale.

Iron	+ 78	Brass	− 1·3
Cobalt	+ 25	Platinum	− 2·4
Zinc	+ 15	Gold	− 6·8
Lead	—	Silver	− 8·6
Tin	+ 0·2	Copper	− 10
		Aluminium ...	− 50
		Magnesium ...	− 50
		Nickel	− 120

The deflection of the current in those marked + is in the same direction in which the conductor itself tends to move in the magnetic field. I cannot vouch for the order of the metals. I have tried three specimens of nickel, and the direction was the same in them all. One of them was pure nickel, furnished me by Prof. Chandler Roberts.

The following remarks were made by the chairman, Sir William Thomson:—

The subject of this communication is by far the greatest discovery that has been made in respect to the electric properties of metals since the times of Faraday—a discovery comparable with the greatest made by Faraday. I look upon it with special interest myself as so closely connected with electrodynamic properties of metals, which formed the subject of my Bakerian Lecture in 1856. I pointed out in that paper, in about § 104, that it was to be expected that magnetic induction would produce change of thermal conductivity and of electric conductivity in different directions in substances perfectly isotropic. I found by mathematical investigation rotational terms, and pointed out that we might expect in bodies which have rotational quality to find the effect of such terms exhibited. But the only influence having that relation to rotation which was necessary for producing the terms in question I pointed out to be the influence of a magnet, and that we might expect that the effect of a magnet upon an isotropic body would be to induce difference of quality in different directions in accordance with the rotatory term, and I said I thought it improbable that the rotatory terms would be found to be null in a body subjected to the influence of a magnet. I look with great delight on Prof. Hall's discovery, as having verified that which I predicted as probable. I did not myself make any serious attempt to discover it. It is the first illustration ever brought out by experiment of one of the most curious and interesting things in the mathematics of æolotropy. The previous mathematical writers dismissed these terms altogether, although they found them in the formula;—dismissed them as something which we could not imagine to exist. I refused to dismiss them, and said there was decided reason that they could exist under the rotational influence which we know to belong to a magnet.

Prof. Rowland said: Mr. Hall had tried the direction of rotation of the plane of polarisation when light is reflected from nickel and iron on Dr. Kerr's plan. The direction was found, if he remembered aright, to be in opposite directions for these two metals. We did not yet know enough to say whether this investigation explains the rotation of the plane of polarisation of light.

Prof. Sylvanus Thompson said he had verified Prof. Hall's result by using a telephone instead of a galvanometer.

Mr. Glazebrook said he had published a paper on the same subject in connection with the rotation of the plane of polarisation of light. Maxwell said this effect (rotation of the plane of polarisation by reflection from a magnet) could be explained by molecular rotation of the particles in the field.

Prof. Fitzgerald asked Sir William Thomson to express an opinion as to how it happens that different substances differ in the direction of this effect. He also remarked that the terms expressing the magnetic force on the matter were the same as those which would express Prof. Hall's observed effect on the current. Was the action to be regarded as an action on the matter or on the current?

Prof. Everett asked whether the current in its deflected condition was oblique (instead of, as usual, normal) to the equipotential surfaces?

Sir William Thomson, in reply, said that effect on matter and effect on the current through it went together, and could not be distinguished. He could not say why the effect in any particular metal was in one direction rather than the other. There was nothing in the mathematical theory to show in which metals it should be in the same direction. Prof. Everett's question might be answered by referring to several corresponding cases. If heat was flowing from end to end of a bar cut obliquely from a crystal, the points of equal temperature in two opposite sides would not in general be exactly opposite to each other. The foundation of the general theory of which this was an illustration had been laid by Prof. Stokes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—On November 3 Sir William Anson, Bart., D.C.L., Fellow and Sub-Warden, was elected Warden of All Souls' College in succession to Dr. Leighton, deceased. Sir William Anson was Vinerian Reader in English Law.

A Fellowship at University College will be offered for competition about the end of next February. The examination will be in biology and kindred subjects. At the last examination for a Biological Fellowship none of the candidates were judged of sufficient merit, and the election was accordingly deferred.

Candidates for the Brackenbury Natural Science Scholarship at Balliol College must communicate with the Master by letter on or before Friday, November 11. Papers will be set in Chemistry, Mechanics and Physics, and in Biology. There will also be an optional paper in Mathematics, and an essay.

At Christ Church there will be one or more Natural Science Junior Studentships elected next March. Candidates must not have exceeded the age of twenty on January 1, 1882. Papers will be set in Chemistry, Biology, and Physics, but no candidate will be allowed to offer himself in more than two of these subjects.

CAMBRIDGE.—On Monday, November 7, Mr. J. E. Marr, F.G.S., was elected to a Fellowship at St. John's College. In 1878 Mr. Marr obtained a First Class in the Natural Sciences Tripos; in 1879 he received a grant from the University to enable him to travel in Bohemia and study the Cambrian and Silurian rocks there; also in 1880 he went in a similar manner to Norway and Sweden. His paper on the Rocks of Bohemia was published in the *Quarterly Journal* of the Geological Society for November 1880. He is at present lecturing for the University at Barrow, Kendal, and Lancaster.

GLASGOW.—Mr. John Macalister Dodds, B.A., Fellow of St. Peter's College, Cambridge, 4th Wrangler, 1880, has been appointed one of the assistants to Dr. Jack, Professor of Mathematics in the University of Glasgow. Mr. Dodds was a distinguished Glasgow student before proceeding to Cambridge. All the four Professors of Mathematics and Natural Philosophy in the Universities of Edinburgh and Glasgow—Prof. Tait, Prof. Chrystal, Prof. Sir William Thomson, and Prof. Jack—are Peterhouse men.

SCIENTIFIC SERIALS

The American Naturalist for September and October, 1881, contains (No. 9, vol. xv.): Carl F. Gessler, variations in a copepod crustacean (woodcuts).—A. S. Packard, jun., Scolopendrella and its position in nature (places Symphyla as a sub-order of Thysanura).—W. H. Dall, American work in the department of recent mollusca in 1880.—D. G. Brinton, notes on the Codex Troano and Maya chronology.

No. 10, vol. xv.: D. H. Campbell, on the development of the stomata of Tradescantia and Indian corn (woodcuts).—Cyrus Thomas, the age of the manuscript Troano.—J. Walter Fewkes, the Physophoridæ (iii.).—R. E. Cull, the Loess in Central Iowa.—A. S. Packard, jun., on the early stages of the

fiddler crab and of Alpheus.—Hartley Barnes, Reason: a psychological distinction.

Bulletin de l'Académie Royale des Sciences de Belgique, No. 8.—Palæontological documents relating to the Cambrian formation of Ardenne, by M. Malaise.—Magic square of the Villa Albani (Rome), by M. Catalan.—On the specific weight of sulphur of Ch. Saint-Claire Deville, by M. Spring.—On the dilatation of sulphur, selenium, and tellurium, by the same.—On the rotatory power of albumen of a dog's blood, by M. Fredericq.—Latitude on a voyage; graphic process, by M. Adan.—On the monazite of the quarries of Nil, St. Vincent, by M. Renard.—Description of a new and precise registering barometer, by M. Delaey.

Journal de Physique, October.—Determination of the wave-lengths of the very refrangible radiations of magnesium, cadmium, zinc, and aluminium, by M. Cornu.—Researches on the refringent power of liquids (continued), by M. Damien.—Experimental researches on the capacity of voltaic polarisation (concluded), by M. Blondlot.—Measurement of the energy expended by an electric apparatus, by M. Potier.—Experiment in optics, by M. Dubois.

La Natura, October.—On the thermal radiation and the temperature of the sun, by S. Cattaneo.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti, vol. xiv. fasc. xv.—Discussion of some mistakes regarding American vines, by Count Trevisan.—Alteration of muscular fibres in a case of locomotor ataxy, by Prof. Golgi.—On photo-anæsthesia in insane persons, by Dr. Raggi.—On variations in the velocity of the arterial current following paralysis of the vagus nerve, by Prof. Solera.—Anomaly in a parrot (*Psittacus Amazonicus*, Lin.), by Prof. Maggi.—Elimination of nitrogen from tyrosine, by Prof. Korner and Dr. Menozzi.—On some products of transformation of chinoline, by Prof. Korner.

Rivista Scientifico-Industriale, September 30.—The axis of rotation of Mercury, by T. Zona.—A compressed air bell-rheometer, by S. Scardona.

Rendiconti delle Sessioni dell' Accademia delle Scienze dell' Istituto di Bologna, 1880–81.—We note here the following:—On the internal discharges of condensers, by E. Villari.—Adaptation of species to their environment; new observations on the genetic history of Trematodes, by G. Ercolani.—On the mode of termination of nerve-fibres in the cornea, and the internal construction of the axis-cylinder, by G. V. Ciaccio.—Anthropometric researches on the Bolognese, by G. Peli.—Chemico-toxicological researches on a putrefied brain, by C. Stroppa and G. Tomani.—Morphological, anatomical, and organic researches on the various species of the genus Citrus, by G. Cugini.—On the course of the river Po, and on works which must be undertaken in presence of danger which threatens the neighbouring population, by P. Predieri.—New method of obtaining pure gastric juice and determining its physiological properties, by L. Vella.—Electric shadows, by A. Righi.—On defective births in the females of *Myoxus glis*, and in the human species, by G. B. Ercolani.—On the ovulation of *Distoma hepaticum* and *lanceolatum* in sheep and oxen, by G. B. Ercolani.

SOCIETIES AND ACADEMIES

London

Chemical Society, November 3.—Dr. Gilbert in the chair.—The following papers were read:—On citraconic and mesaconic ethers and malic and fumaric acids, by W. H. Perkin. The author has carefully investigated the physical properties of the methylic and ethylic ethers of citra- and mesaconic acids. Dr. Gladstone has also measured their refractive indices. The citraconic ethers boil at a higher temperature than the mesaconic ethers, but their specific gravities, magnetic rotatory power, and refractive indices are lower. Only one anhydride can be obtained from maleic and fumaric acids, one from citra- and mesaconic acids, and one from α and β coumaric acids. Maleic anhydride can be obtained directly from malic acid by heating with an excess of acetylic chloride.—On the action of potassium cyanide on bismuthous nitrate, by M. M. P. Muir. A puce-coloured body is formed, $Bi_5(CN)_6O_{15}$; by heating with strong potash Bi_4O_7 is obtained.—On the atomic weight of bismuth, by M. M. P. Muir. The author has analysed bismuthous chloride, and obtained as a mean atmospheric weight 210·46, but he is not satisfied with the results, and hopes to obtain better numbers by the synthesis of bismuthous iodide.—Additional observations on the halogen salts of bismuth, by M. M. P. Muir.—Note on the action of sulphuric acid on zinc and tin, by M. M. P. Muir and C. E. Robbs.—On the volumetric estimation of bismuth in the form of oxalate, by M. M. P. Muir and C. E. Robbs.—Note on the influence of water on the reaction between potassium iodide and chlorine, by M. M. P. Muir and R. Threlfall.—Laboratory notes, by M. M. P. Muir. 1. Lecture experiment showing the effect of "*a*" time, "*b*" temperature, "*c*" mass. This consists in adding a solution of bismuth iodide in hydriodic acid to each of three beakers, one containing 100 cc. of cold water, 100 cc. of hot water, and 500 cc. of cold water. 2. The solution of manganese dioxide and manganese ores in hydrochloric acid is much hastened by potassium iodide. 3. A new method of detecting tin in the presence of antimony: by boiling with metallic copper and testing for stannous salt with mercuric chloride. 4. To detect the haloid acids in presence of nitrous and nitric acids.—On suberone, by R. S. Dale and C. Schorlemmer.—On sulphonic acids derived from isodinaphthyl, by Watson Smith and T. Takamatsu.—On phenyl naphthalene, by Watson Smith and T. Takamatsu.—On dimethylmalonic acid and dimethylbarbituric acid, by L. T. Thorne. The author confirms the conclusions arrived at by Conrad and Guthzeit.

Paris

Academy of Sciences, October 31.—M. Wurtz in the chair.—On account of the death of M. Bouillaud the *séance* was adjourned.—*Comptes rendus* for the week contains—Observations of Cruls' comet (*b* 1881) at Marseilles Observatory, by M. Stephan.—Elliptic elements of the same comet, by M. Bossert.—Observations of comets *c* 1881 (Schaeberle), *d* 1881 (Encke), *e* 1881 (Barnard), *f* 1881 (Denning), at Paris Observatory, by M. Bigourdan.

Vienna

Imperial Academy of Sciences, October 20.—V. Burg in the chair.—L. F. Tiefenbacher, on the forest and its relations to landslips (a supplement to a work by the same author, on landslips, their causes, effects, and treatment).—F. Austerlitz, a contribution to the ballistic problem.—E. Mahler, theory of curvature of an *n*-fold manifoldness.—E. Weiss, computation of the elements and ephemeris of Barnard's comet (continued).

Göttingen

Royal Society of Sciences, June 4.—Absolute measurement of the strength of terrestrial magnetism by a galvanic method without determination of time, by F. Kohlrausch.—Theory of curves of double curvature, by A. Enneper.—Remarks on some transformations of surfaces, by the same.

August 6.—Lycopodin, by K. Bædeker.

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THURSDAY, NOVEMBER 17, 1881

SYSTEMATIC MINERALOGY

Text-Book of Systematic Mineralogy. By Hilary Bauerman, F.G.S., Associate of the Royal School of Mines. (London: Longmans, Green, and Co., 1881.)

THE text-books of Mineralogy written for English readers are so extremely small in number that the publication of a new one may be almost looked upon as an epoch in the history of the science. The text-books already in existence are in many respects very unsatisfactory, and in general character fall far below the standard of those of France and Germany. The symbols adopted in them for the faces of crystals are generally those of Naumann, whilst the simple and elegant symbols of Miller, if mentioned at all, seem to be regarded as intended for ornament rather than for use. As for the advances made by theoretic crystallography during the last quarter of a century, no account, save that to be found in the excellent little work of Mr. Gurney, has yet been offered to the English student.

Mr. Bauerman had thus a clear field and a splendid opportunity. It will be interesting to consider how far the result of his labour is worthy of the occasion.

We find, on opening the book, that the Descriptive Mineralogy, which the author's wide experience and extensive travel should render highly instructive, has been assigned through force of circumstances to a supplementary volume: of the 367 pages of the present one, 200 are given up to the geometrical, 100 to the physical, chiefly optical, and the remainder to the chemical and other properties of minerals. One immediately remarks with pleasure the numerous figures of crystals distributed throughout the work, all well drawn and clearly printed, and what is almost as important to the student, having wherever practicable the Millerian indices affixed to the faces.

On coming to the letterpress, however, one soon finds that there is something wrong; in fact, from the first page almost to the last there seems an evident disposition to perplex the reader. The style is very confusing throughout. On p. 5, for instance, we are informed that "quartzite and statuary marbles are aggregates of particles of quartz and calcite into masses of a slaty or granular texture." On p. 7 we find the following:—

"The leading property of crystals, as distinguished from mere geometrical solids, is the invariability of the angles between corresponding faces in different individuals of the same substance. There is usually a very marked *symmetry* to be noticed in the arrangement of their plane faces and edges, and occasionally of their points also, although the latter symmetry is not essential, crystallographic symmetry being one of direction and not of position, so that two parallel planes or two parallel lines are not distinguished from one another, and on that account the invariability of the angles is a paramount consideration."

Leaving out of sight the fact that the accuracy of the above distinction may be very reasonably contested, we much doubt the ability of the ordinary mineralogical student to master the compound nature of the latter sentence. On p. 10 we are puzzled on being told that "a polyhedron may be turned through an aliquot part of a whole revolution without its position in space as a whole being changed"; on p. 12 we find that the tetragonal system is characterised by the existence of *two* axes of binary symmetry, while on p. 112 *four* are mentioned; on p. 15 we are informed that if α, β, γ are all different, the molecular net-work has no symmetry, while on the following page it is said that, granted certain relations between these different quantities, there will be symmetry; on p. 19 we are told that the values of h, k, l are in no wise altered by multiplying them by any numerical co-efficient; and from p. 24 it will be concluded that a crystal with a "concave" angle is necessarily a twin.

On p. 36 it is stated that "the test of whether we have really four faces of *one* crystal is the rationality of this anharmonic sine-ratio when reduced to numbers" It is a well-known fact that in every zone of the cubic system, and in particular zones of the tetragonal and rhombohedral systems, the anharmonic ratio of any four planes belonging to *two* twinned crystals will be rational.

The account of the inter-relations of the various holohedral forms of each crystallographic system is not such as will relieve this branch of the subject from being still looked upon by the English student as somewhat dry and wearisome, while the attempt to evolve the hemihedral forms must cause the learner to despair. Thus the chapter on the Tetragonal System begins as follows:—

"The complete symmetry of this system is contained in an upright prism upon a square base, which has quaternary symmetry about a principal axis parallel to the vertical edges, and binary about four lateral axes."

Instead of an explanation there is then a statement of the fact that only certain permutations of the indices are possible: next follows a calculation, one of the principal features of which is the use of some spherical triangle characterised only by the fact that it is described *about* the pole of the principal axis and has a side represented by π, which symbol has been unfortunately selected to represent an *arbitrary* arc. The hemihedral forms are then arrived at by arranging the symbols of the faces of a complete form in a particular order, and then halving the faces, or the symbols, or the table, it is not clear which, in some symmetrical way not easy to discover (see pp. 89 and 120).

On p. 152 we find that, in the case of oblique crystals the axis of symmetry is a direction of "physical equivalence," while from p. 156 we should conclude that a face is "crystallographically possible" when it has a similar face parallel to itself.

In the discussion of twin crystals the relation in which the twin axis and the twin plane stand to the lines and planes of the crystalloid system is not clearly expressed. It may be worth while to point out that on p. 170 the somewhat common error is made of considering a face of the cube as the twin plane of the two interpenetrant tetrahedra, whereas a little reflection will make it clear that the twin plane is really a dodecahedral face. On p. 352 the striations on the cube faces of iron pyrites are, strange to say, referred to as *twin striations.* In describing a goniometer, of which the picture on p. 192 is no doubt very ideal, it is remarked that "the angle through which the circle is rotated will be the supplement of the dihedral angle required, *if it was originally set to zero.*"

On the same page a probable injustice is done to the instrument, for we find that "in all cases the observation must be often repeated to obtain results of any value." What can be meant by the statement on p. 198, that the octahedron, or unit pyramid, is always the largest, and the cube rectangular prism, or pinakoid the smallest, of the constituent forms of any combination? On p. 205 we learn that density and hardness are common to all solids alike, and are therefore *independent of structure*. A definition (p. 212) informs us that a substance is *ductile* when it can be cut with a knife, but crushes to powder under a hammer, copper pyrites being cited as an example; and on the same page we find as an illustration of toughness of a mineral that "Malleable native Copper, especially when intimately mixed with siliceous vein-stuff and some varieties of Hematite and Iron Pyrites, has the property of toughness in a high degree."

The discussion of the optical properties is more unsatisfactory still. On p. 225 is to be found the following remarkable statement:—

"The movements in such a medium can only be reduced to order by supposing them to be made up of portions of homogeneous substances of different properties, and treating each one separately."

The proof of the existence of a minimum angle of deviation as submitted on p. 233 can scarcely be meant as serious; but to this curious proof should not have been appended an erroneous translation of the formula into words. On p. 235 the azimuths of vibration of an ordinary ray of light are said to change *continuously*, but so very rapidly that the changes are not perceptible to the eye; on the following page we read of "impulses having different velocities." Perhaps matters reach a climax about p. 245, where the intelligibility of the book for a brief period suffers total eclipse, as perhaps may be imagined when we read that "these orthogonal *forces* are called the *axes* of optical elasticity." On p. 263 one of the rays produced by double refraction is said to be "an extraordinary ray in all directions but those of the optic axes." Phosphorescence is, according to p. 290, "the power of emitting light in a dark place." On p. 293 we find a serious misapprehension as to the precise nature of the method employed by Fizeau for the determination of the expansion of crystals. One infers from the explanation here given that the interference rings, produced by help of a plane crystal surface and a lens, are *distorted* on change of temperature, and that the measurement of this distortion serves for the determination of the coefficient of dilatation for different directions in the plane surface; as a matter of fact Fizeau by his method determined with each crystal section the dilatation in only *one* direction, namely, that normal to the plane surface.

It is difficult to understand how Mr. Bauerman has contrived to allow so many loose statements to creep into his book; and we can only surmise that he has himself not had the time or the opportunity for a careful revision of the proofs. At any rate it will be evident from the above that a careful revision is absolutely required before the book can take its proper place in mineralogical literature. We trust that the present edition may be speedily disposed of, and that Mr. Bauerman will thus be enabled to offer to the English student a second and revised edition of a work, the want of which is urgently felt by every teacher of the subject.

L. FLETCHER

A TREATISE ON CHEMISTRY

A Treatise on Chemistry. By H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S., Professors of Chemistry in the Victoria University, Owens College, Manchester. Vol. III. The Chemistry of the Hydrocarbons and their Derivatives, or Organic Chemistry. Part I. 8vo. (London: Macmillan and Co., 1881.)

THE term "Organic Chemistry" was originally used to denote the chemistry of compounds produced in the living vegetable or animal organism, all of which contain the element CARBON. For a long time indeed it was supposed that these compounds were peculiarly the products of living organisms, being formed under the influence of a so-called *vital force*, and that they could not be produced, like those of the mineral world, by artificial means. But the course of research has shown that this idea was erroneous, and that a large number of the more important organic bodies—hydrocarbons, alcohols, acids, &c., originally known only as products of the living organism—can be formed synthetically from their ultimate elements. The name "Organic Chemistry" has thus acquired a new signification, and in its widest sense is now used to denote the chemistry of carbon-compounds. As however some of these compounds, viz. the oxides and sulphide of carbon, have long been known to be producible by direct combination of their elements, and have accordingly been described in Manuals of Chemistry amongst inorganic compounds, the authors of the present treatise have thought it desirable to use the term "Organic Chemistry" in a somewhat narrower sense, viz. as signifying the CHEMISTRY OF THE HYDROCARBONS AND THEIR DERIVATIVES.

The volume commences with a historical sketch of the development of this department of the science, tracing it from the few facts respecting organic bodies known to the ancients, to the discoveries of Scheele, Lavoisier, Berzelius, Liebig, and numerous other workers, down to the present time—dwelling especially on the idea of Compound Radicals introduced by Lavoisier, and further developed by Berzelius, and by Liebig and Wöhler in their classical research on Bitter Almond Oil and its Derivatives, published in 1837—thence to the theories of Substitution and Types, founded chiefly on the researches of Dumas, and of Laurent and Gerhardt, and to the subsequent fusion of the Radical and Type theories brought about by the experiments of Williamson on Etherification, and those of Wurtz and Hofmann on the Compound Ammonias.

The next division of the work treats of the methods of ORGANIC ANALYSIS, which are explained in considerable detail, and illustrated by admirable diagrams; also of the determination of Vapour-density, in which the latest methods introduced by Victor Meyer are fully described, after which we come to the Determination of Molecular Formulæ, the explanations of which are characterised by singular clearness.

Next follows the CLASSIFICATION OF CARBON-COMPOUNDS, which are divided into groups according to the mode of linking of the carbon-atoms, the principal divisions being the Fatty or Paraffin group, in which the carbon-atoms are joined together in a single open chain, and of the Aromatic or Benzene group, in which the

atoms are supposed to form closed chains. Objections have sometimes been raised against this division as somewhat arbitrary; but we cannot help thinking that it is justified by the peculiar kind of isomerism, depending on the relative position or "orientation" of the substituted groups or radicals which exists amongst benzene derivatives.

The formation, constitution, and general properties of the Paraffins are next explained, together with those of the several groups of bodies, Alcohols, Acids, Amines, &c., derived from them by substitution, and the remainder of the volume is devoted to the special description of these several compounds, which are arranged according to the number of carbon-atoms contained in them, beginning with the lowest or Methyl-group, the fundamental hydrocarbon or paraffin of each group being first described, and then in succession the Alcohols, Ethers, Nitrogen-bases, Phosphorus-bases, Organo-metallic compounds, Aldehydes, Acids, Ketones, Sulphur-compounds, &c., derived from it.

All these compounds are clearly and ably discussed, especial attention being given to those which are of industrial importance, *e.g.* common Alcohol, Acetic Acid, and the Higher Acids of the Fatty series, which enter into the composition of soap. Several industrial processes are described in considerable detail, and amply illustrated by figures, *e.g.* the separation of the Paraffin-oils by fractional distillation, the manufacture and rectification of Alcohol, the testing of the strength of Spirits and of Wine and Beer, the preparation of Vinegar, and the manufacture of Soap. And here perhaps it may not be out of place to point out the great practical importance of Organic Chemistry, which, strange to say, has been called in question by some writers in the periodical press, who have spoken of it as consisting, in great part, of elaborate trifling about compounds of little practical importance, but rejoicing in names of fearful length, and formulæ of excruciating complexity—and in fact treating this branch of chemical science as altogether of second-rate importance in comparison with Mineral Chemistry. Now the importance of this last-mentioned branch of chemistry, which includes the description of the Metals and their Compounds, is of course beyond all question; but it is perhaps not too much to say that at least an equal value in a practical point of view may be ascribed to that department of the science which is concerned with the materials of our food and clothing, and with the constitution of the compounds which make up the bodies of plants and animals. To remove any doubt that may yet exist as to the practical importance of Organic Chemistry, we can imagine nothing more effectual than a perusal of the volume under consideration, the appearance of which will doubtless be hailed with pleasure by all who are interested in the subjects of which it treats. H. WATTS

OUR BOOK SHELF

Acoustics, Light, and Heat. By Thomas W. Piper. (London: George Philip and Son, 1881.)

THIS little work is not without its merits, the descriptions of the simpler phenomena and laws of these branches of physics being for the most part clear, accurate, and couched in easy language. The arrangement adopted in the chapters of the book is a departure, and we think not a very wise one, from the usual order of subjects in elementary text-books of physics. After a preliminary chapter on the atmosphere, its elasticity and its weight, the author plunges into vibratory motion, and under this head treats of acoustics. Chapter III. is on rectilinear motion, under which heading we have the following subjects:—The reflection of sound, the linear propagation of light, reflection of light and its applications, convection, radiation, and conduction of heat, laws of curved mirrors, laws of refraction, lenses, magic lantern, refraction of sound, spherical aberration of lenses, and, lastly, properties of matter. We have quoted these in the order in which they occur, and cannot help thinking that, however clearly the individual subjects are treated of, this heterogeneous lumping together of them must hamper the comprehension of beginners. Chapter IV. deals with the conservation of matter, including expansion by heat; Chapter V. is on thermometers. Chapter VI., on the conservation of energy, is another example of the author's peculiar method. It begins with the correlation of forces, deals with the prismatic spectrum, diathermancy, acoustic resonance, the laws of vibrations of strings, and specific heat. The book concludes with a chapter on sensation, optical and acoustical. Except for these aberrations of arrangement, and for one or two slips, the book would be a satisfactory one for beginners in natural philosophy.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Parasitic Habits of Molothrus

IN the "Origin of Species" I adopted the view maintained by some writers, that the cuckoo lays her eggs in other birds' nests, owing to her habit of laying them at intervals of two or three days; for it could hardly fail to be disadvantageous to her, more especially as she has to migrate at a very early period, to have young birds of different ages and eggs all together in the same nest. Nevertheless this occurs with the non-parasitic North American cuckoo. If it had not been for this latter case, it might have been argued that the habit of the common cuckoo to lay her eggs at much longer intervals of time than do most other birds, was an adaptation to give her time to search for foster-parents. The Rhea or South American ostrich is believed likewise to lay her eggs at intervals of two or three days, and several hens deposit their eggs in the same nest on which the male sits; so that one hen may almost be said to be parasitic on another hen. These facts formerly made me very curious to learn how the several species of Molothrus, which are parasitic on other birds in very varying degrees, laid their eggs; and I have just received a letter from Mr. W. Nation, dated Lima, September 22, 1881, giving me information on this head. He says that he has there kept in confinement for a long time *Molothrus perpurascens*, and has likewise observed its habits in a state of nature. It is a resident species of Western Peru, and lays its eggs exclusively in the nests of a sparrow (*Zonotrichia*), starling (*Sturnella bellicosa*), and a pipit (*Ænthus chii*). He then proceeds: "The eggs of the sparrow are very much like those of the Molothrus in size and colour. The eggs of the starling are larger and somewhat different in colour; while the eggs of the pipit are very different both in size and colour. Generally one egg of the Molothrus is found in a nest, but I have found as many as six. The young Molothrus does not always eject its foster-brothers; for I have seen a young one nearly fully feathered in a nest with two young

starlings. I have also found two young birds of the Molothrus nearly fully feathered in the nest of a starling; but in this instance the young starlings had been ejected from the nest." He then states that he had long kept in confinement a male and female of this species of Molothrus, which are now six years old. The hen began to lay at the age of two years, and has laid each time six eggs, which is the number laid by Icterus, a near ally of Molothrus The dates on which the eggs were laid this year are as follows:—February 1, 6, 11, 16, 21, and 26; so that there was an interval of exactly four clear days between the laying of each egg. Later in the season she laid six additional eggs, but at much longer intervals and irregularly, viz. on March 8, April 6 and 13, May 1, 16, and 21. These interesting facts, observed by Mr. Nation in relation to a bird so widely distinct from the cuckoo as is the Molothrus, strongly support the conclusion that there is some close connection between parasitism and the laying of eggs at considerable intervals of time. Mr. Nation adds that in the genus Molothrus, out of every three young birds he has invariably found two to be males; whereas with Sturnella, which lays only three eggs, two of the young birds are, without any exception, females.

CHARLES DARWIN

Down, Beckenham, Kent, November 7

The Velocity of Light

IN reply to Mr. Macaulay (NATURE, vol. xxiv. p. 556) I will endeavour to explain more clearly the statements, made in my former communication on this subject (NATURE, vol. xxiv. p. 382). On one important point the explanation will include a correction.

With reference to the group-velocity U, we know from Fourier's theorem that any disturbance travelling in one dimension, can be regarded as resulting from the superposition of infinite trains of waves of the harmonic type, and of various amplitudes and wave-lengths. And we know that any one of these trains, of wave-length λ, is propagated unchanged with a velocity V, which we regard as a known function of λ, dependent upon the nature of the medium.

Unless we can deal with phases, a simple train of waves presents no mark by which its parts can be identified. The introduction of such a mark necessarily involves a departure from the original simplicity of a single train, and we have to consider how in accordance with Fourier's theorem the new state of things is to be represented. The only case in which we can expect a simple result is when the mark is of such a character that it leaves a considerable number of consecutive waves still sensibly of the given harmonic type, though the wave-length and amplitude may vary within moderate limits at points whose distance amounts to a very large multiple of λ. We will therefore suppose that the complete expression by Fourier's series involves only wave-lengths which differ but little from one another, and accordingly write it—

$$a_1 \cos\{(n+\delta n_1)t-(\kappa+\delta\kappa_1)x+\epsilon_1\}$$
$$+\, a_2 \cos\{(n+\delta n_2)t-(\kappa+\delta\kappa_2)x+\epsilon_2\}+\ \ldots\ ,$$

or in the equivalent form—

$$\cos(nt-\kappa x)\,\Sigma a_1 \cos(\delta n_1 t-\delta\kappa_1 x+\epsilon_1)$$
$$-\sin(nt-\kappa n)\,\Sigma a_1 \sin(\delta n_1 t-\delta\kappa_1 x+\epsilon_1),$$

where $\kappa=2\pi/\lambda$, and $n=\kappa V$. From this we see that, as in accordance with the suppositions already made,

$$\frac{\delta n_1}{\delta\kappa_1}=\frac{\delta n_2}{\delta\kappa_2}=\ \ldots\ =\frac{dn}{d\kappa},$$

the deviations from the simple harmonic type travel with velocity $dn/d\kappa$, and not with velocity n/κ, that is with velocity $d(\kappa V)/d\kappa$, and not with velocity V.

I now pass on to the theory of Foucault's experiment. If D be the distance between the fixed and moving mirrors, ω the angular velocity of the latter, then the angle through which the mirror turns in the time occupied by the wave in making the double journey is $2D\omega/V$, and the angular deflection θ, which is the immediate subject of observation, is according to the usual view—

$$\theta=\frac{4D\omega}{V}.$$

Now it is here assumed that the deflection is due merely to the change of position of the mirror between the two reflections, and that the wave returns to the mirror with its front parallel to the position occupied immediately after the first reflection, as would be the case if the mirror were at rest. But if V be a function of λ, this assumption is not true. Besides the deflection above considered, there is another depending upon the fact that the wave front rotates in the air between the two reflections. The rotation is a consequence of the inclination to one another of successive wave fronts, which involves a variation of wave-length and therefore of velocity at points situated on the same wave-front in a line perpendicular to the axis of rotation. Denoting distances measured along this line by x, we have for the angular velocity of the wave's rotation—

$$\omega'=\frac{dV}{dx}=\frac{dV}{d\lambda}\,\frac{d\lambda}{dx},$$

in which $d\lambda/dx$, representing the angle between successive wave-fronts of similar phase, is equal to $2\omega\lambda/V$. Accordingly—

$$\omega'=2\omega\frac{d\log V}{d\log\lambda},$$

and the actually observed rotation is—

$$\theta=\frac{4D\omega}{V}\left(1-\frac{d\log V}{d\log\lambda}\right).$$

The result of a calculation which leaves the aërial rotation out of account is therefore not V, but—

$$\frac{V}{1-\dfrac{d\log V}{d\log\lambda}}$$

Now

$$U=\frac{d(\kappa V)}{d\kappa}=V\left(1+\frac{d\log V}{d\log\kappa}\right)=V\left(1-\frac{d\log V}{d\log\lambda}\right);$$

so that the result of the experiment is V^2/U, and not as previously stated the group velocity U itself. The error arose from a mistake as to the direction of the effect of ω'.

The force of the arguments which I founded upon these considerations is increased rather than diminished by the correction, and with Mr. Michelson's evidence on the same side of the question almost excludes any appreciable variation of V. It should be noticed that by the combination of the two methods of the toothed wheel and of the revolving mirror we have the means of determining both V and U, and the results of Cornu and Michelson appear to prove, independently of astronomical observation, that there is no sensible difference between them.

Indeed by a slightly varied arrangement it would seem possible to determine V directly from Foucault's experiment. If a convex lens were so interposed at the distant station that the fixed mirror occupied its focus, the sides of short and long wave-length would be interchanged, and thus the rotation acquired during the outward journey would be neutralised during the return.

RAYLEIGH

The Struggle of Parts in the Organism

I AM very glad to learn that Mr. Romanes fully accepts as "well-known and unquestionable" the definition of the term *law of nature* which I propounded as expressing its true scientific sense; but I would suggest to him, as to other writers who are accustomed to speak of such laws as "governing" phenomena,[1] whether the use of such "metaphorical" language is not objectionable, as tending to keep up in the *un*scientific mind the notion of the "coercive" and "self-sufficient" agency of natural laws. I am glad also to be able to express my entire accordance with Mr. Romanes in regard to the inferiority of the teleological argument based on *special instances* of adaptation of means to ends, to that which is based on the *general order* which we designate by the term law. For I maintained this view even in that remote pre Darwinian age in which my scientific life commenced, urging to the best of my young ability, forty-three years ago,[2] that the principles admirably laid down by Whewell in regard to physical inquiry, viz. that final causes should be excluded, because "we are not to assume that we know the objects of the Creator's design, and put the assumed purpose in the place of a physical cause," and that "the notion of design and end is transferred by the researches of science from the

[1] I continually meet with this phrase in the pages of NATURE.

[2] See *British and Foreign Medical Review* for April, 1838: "Physiology an Inductive Science."

region of facts to that of laws," are no less applicable to physiology than to physics; although Whewell himself (in his "History of the Inductive Sciences") had maintained the contrary. The full acceptance of the doctrine of evolution as our highest expression of the *order* of creation seems to me to lead to a much nobler conception of the Intelligent Cause of that order than any accumulation of such individual adaptations as might be made by the "mechanic-god" of Paley.

WILLIAM B. CARPENTER

56, Regent's Park Road, N.W., November 14

The Aurora and its Spectrum

YOU have already illustrated in NATURE the aurora and electric storm of January 31. Though somewhat tardily, another drawing with a description of this fine display has found its way into my hands, of sufficient interest, I think, to be added to those already published. It comes from Mr. C. L. Prince, the well-known meteorologist of Crowborough Beacon, Tunbridge Wells, who says, "I inclose a photo of my sketch on a slate.[1] I had a splendid sight of the aurora at about 9h. 15m. It soon became very hazy, but I saw it again at 11h. 15m., when I made the sketch (see drawing). The arch was exceedingly well defined, and extended about 80° along the horizon. At 11h. 20m. some more brilliant streamers shot up along the whole convexity of the arch, and the two *patches* of *light* became very tremulous, almost shifting a little from right to left; but I particularly noticed that they did not vibrate *simultaneously*, *i.e.* if one indicated motion the other was quiescent *until* the first had ceased to show excitement, and this action was alternating for nearly an hour. At 11h. 40m. the arch had much contracted, and by midnight had nearly faded away. The whole phenomenon was

free from colour. I noticed a few small meteors. The night was quite calm; wind south-west."

This account seems to me interesting in connection with an observation made by my friend Dr. Vogel of Potsdam, that during the aurora of April 9, 1871, certain lines in the spectrum alternated in intensity with the character of the discharge, some brightening as others faded.

Mr. Prince does not mention any spectroscopic observations, and while noting this will you permit me to make a few remarks on the "spectrum of the aurora," an old hobby of mine. I notice that Dr. Spottiswoode, P.R.S., in his lecture delivered before the British Association at York on September 5 last (NATURE, vol. xxiv. pp. 572, 3, "On the Electric Discharge, its Forms and Functions,") has referred to the aurora in connection with experiments showing that the discharge in rarefied gases differs from that at higher pressures, and that the difference corresponds to that observed between the flickering play of the aurora and the crashing spark of the lightning-flash. After then referring to the questions of height and colour of the auroral discharge, Prof. Stokes' theoretic view of the connection of earth-currents, disturbances of the magnetic needle, and solar radiation is dwelt upon. In NATURE, vol. xxiv. pp. 613-18 (lecture by Prof. Stokes, Sec.R.S., in the South Kensington Theatre, on "Solar Physics"), this theoretic view is set forth, and the aurora is described as a flash of lightning passing through the higher regions of the atmosphere where the air is rarefied. There are, I think, some objections to this theory founded upon certain circumstances of the aurora itself, such, for instance, as the well-authenticated cases of auroræ seen close upon the surface of the earth.

The passage, however, in Prof. Stokes' lecture which particularly struck me is this: "But what of the auroræ? It has long been recognised that the aurora is an electrical phenomenon. It has been supposed to be imitated, *and there can be no doubt that the supposition is a correct one* [the italics are mine] by sending an ordinary electric discharge through a highly exhausted tube."

Now it may be true that the aurora is thus imitated so far as external appearance is concerned, and it has long been a favourite idea that this imitation in some way extended to the aurora's actual composition; but what does that Ithuriel spear, the spectroscope, say upon that point—a point which gains the more importance from the fact that such an instrument is mentioned by Prof. Stokes (p. 614) as the true touchstone for the aurora? It says positively that Prof. Piazzi Smyth's citron line, the one true test of the aurora, has never yet been seen in any electric discharge whatever which we have yet produced, whether in air at ordinary pressure, or rarefied; that the red line (its companion in some auroræ) is equally noticeable for its absence therefrom; and that of the remaining faint and less marked lines one or two only have with doubt and uncertainty been by some referred to the air spectrum as excited by the electric spark or glow. The late Prof. Ångström endeavoured to place some of these fainter lines in accord with the spectrum bands of the violet pole in Geissler air-tubes, but the comparison failed on critical examination. Prof. Vogel has also considered the aurora might probably be an air-spectrum modified by conditions of temperature and pressure. The Professor's actual line comparisons, however, quite failed as to the citron and red lines, and could hardly be called a success as to the fainter ones. In fact any analogy between the aurora spectrum and the spectrum of the electric discharge in air is all but hypothetical, and the aurora still maintains that mysterious quality which distinguishes it from electric discharges of all sorts, and indeed everything else, viz. its peculiar spectrum.

I therefore again plead the necessity for spectrum observations in connection with the aurora, a point from which Prof. Stokes' lecture, I am afraid, owing to its absence of any remarks on the subject (save that before referred to) is somewhat calculated to draw them away. It is certainly *possible* that some special gas *may* exist in the upper regions of the atmosphere giving rise to the citron, perhaps the red, lines; but then (as Prof. Smyth remarks) if so, why, being an emission spectrum in the aurora, does it not, according to the theory of exchanges, appear as an absorption spectrum or dark lines in the solar spectrum? Even, too, could this be shown, it would still remain an unexplained fact that such a gas has hitherto failed to be recognised in any other body, celestial or terrestial.

To sum the matter up, the electric discharges in vacuum-tubes, as tested by Prof. Stokes' prism and slit, no more represent the aurora than did the cirrus cloud illuminated by the light of the moon, mentioned by him, which also simulated it.

Upon reliable authority the spectrum of lightning may be considered that ordinarily given by a spark in air; but when we come to rarefied discharges and the aurora, the same comparison does not hold good; and where the electrician has to leave the matter, the spectroscopist has yet to take it up.

To aid in solving the aurora's mystery I would invite all spectroscopists, armed with suitable instruments, persistently to aim at accurate micrometer readings of the aurora spectrum. The approximate places of the lines are pretty well established, but their actual wave-length positions are much wanted, for so only may we hope to master one of the remaining riddles of science.

J. RAND CAPRON

Guildown, November 1

[1] I commend this method of sketching to other observers, the slate pencil showing white on the dark slate being readily photographed with good effect, displaying the aurora light on a dark ground.—J. R. C.

Arctic Research

"PROGRESS of Arctic Research since the Foundation of the British Association," by C. R. Markham, C.B., F.R.S. Such is the title of a very able and instructive paper read before the Geographical Section of the British Association at York on September 6 last, and published *in extenso* in the November number of the *Proceedings* of the Royal Geographical Society. The casual reader of this history may suppose it to be a fair and correct record of half a century of Arctic exploration, and that

the names of distinguished men commanding naval expeditions, who themselves, or the officers under them, did a large amount of discovery and good scientific work, are mentioned, however briefly. Yet this is far from being the case. True, some of those expeditions which have been considered unworthy of notice were sent to the far north to gain tidings of the lost expedition under the good and noble but unfortunate Franklin; yet, in addition to doing an immense extent of sledging, by which many hundred miles of *new* coast were traced, they collected much scientific information, little, if any, less valuable than that brought home by the Nares Expedition, whose object was purely scientific.

The names of Kellett, Belcher, and Austin are conspicuous by their absence, except a notice of the officer who acted as second to the latter, and who made a comparatively short sledge journey. We can scarcely suppose that the author was in any way influenced by the fact that he himself sailed in the same vessel under the immediate command of the officer whom he selects for notice, whilst wholly ignoring Admiral Austin, the chief in command.

The names of the Americans, Kane and Hayes, who with very inferior means traced *more* than 300 *miles* [1] of the unknown shores of Smith's Sound, are left out, although each was awarded the gold medal of the Royal Geographical Society—the highest honour that can be bestowed on an explorer—for their Arctic discoveries, as being the most important of the year in which they were made. These are a few examples to prove what has been said.

The author attempts to show that the system of sledging adopted by the Government Naval Expeditions is all but perfect, and that the first long sledge journeys were performed by them. Both these statements admit of question. The sledging arrangements are more or less defective in almost every particular. The tents are bad shelters, far inferior to snow-huts; the sleeping-bags are objectionable, as they prevent transmission of caloric from one individual to the other. The bag itself, being exposed all day to a temperature of perhaps 20° or 30° below zero, is so cold when the occupant gets inside, that all the moisture from the breath, &c., gets condensed upon it, making this bed after a few days' use like "sheet iron" (as remarked by a naval officer who had some unpleasant experience of the fact) and afterwards, when thawed by the extraction of most of the animal heat from the shivering tenant, becomes a veritable "wet blanket." Besides this blanket bag each man before going to rest (?) struggled into what is called a "jumper" made of thick duffle, cold as the other night-gear, thrusting the arms into the sleeves, thus keeping these unfortunate members separated by two folds of a thick non-conductor from the body that owned them, a procedure wholly opposed to both experience and science. To conserve the animal heat the Indian and white *voyageur* either take off their coats or take their arms out of the sleeves when camping out in winter. The Eskimo strips to the waist in his snow hut. It is only the naval Arctic sledge parties that act differently, with very uncomfortable results. The construction of the sledges is very defective for certain conditions of snow when in a semi-packed state—the sledge-runners then sink down six or seven inches, and have to be dragged with great difficulty *through* the snow, not *over* it. The dead weight—exclusive of food and fuel—to be hauled on this "admirable system" usually amounted to 85 or 90 lbs. per man, which weight has been reduced under another system to 35 or 40 lbs. per man without loss of efficiency.

"Long-sledge journeys," which Mr. Markham claims to have been initiated by the Government Naval Expeditions, were made at the rate of twenty miles or more a day by civilians, before the "naval system" was put in use, the first occasion of which was by the most experienced of Arctic explorers, Sir James C. Ross, in 1849, when the results were by no means satisfactory, considering the large number of men employed; a small party of five Hudson's Bay men having accomplished more than double the distance at nearly double the daily rate two years before over very difficult ice.

Mr. Markham "formulates three canons," which, he says, "are equally important, as the true methods for future Polar research," but the latter of these, namely, "to reach an advanced position within the unknown area, it is necessary to follow a coast line trending northwards, *with a western aspect*, is of most interest to the geographical inquirer."

[1] This distance (300 miles) of new discoveries is that credited to the Nares Expedition by Mr. Markham.

The four words I wish to comment upon are in italics. Had not Mr. Markham given examples of his meaning by mentioning Foxe's Channel and Regent's Inlet, I should have supposed "*western aspect*" a misprint.

It is a curious but certain fact, established by men who have been there, that the shores of all bays and inlets on the northern coast of America, the shores of all inlets and of the great islands lying north of America, having a *western aspect*, are usually ice-blocked, whilst the shores having an *eastern aspect* are comparatively free from ice and navigable. As cases in point Hudson's Bay, Regent's Inlet, Victoria Strait, the shores of Banks Land and Melvile Island, also Smith Sound,[1] are all far more ice-obstructed on the shores having a western than on those having an eastern aspect.[2]

The greater frequency of westerly and north-westerly winds and gales in the western hemisphere in high latitudes are of themselves sufficient to produce the effect I have mentioned, and to form the so-called "ancient ice" in a month or less.

The route by the west shore of Franz-Josef Land is named as favourable for getting far to the north. This may be true, but from the formation of the land it may be considered as by no means safe. The most experienced navigators of these seas state that Franz-Josef Land may perhaps be reached once in every four or five years, as the condition of the ice in Barentz Sea is very uncertain. Supposing this to be true, might not the vessel that was fortunate enough to reach these interesting islands be detained there rather longer than was either safe or agreeable? Already some not unreasonable anxiety is felt for Mr. Leigh Smith in his fine vessel manned by able icemen, who, it is believed, sailed in the direction indicated. Fortunately he is in every respect well provided to face *one* Arctic winter.

That a large quantity of heavy ice is to be generally met with in the Sea of Barentz is not difficult to account for—Spitzbergen on the west, Franz-Josef Land on the north, and Novia Zemblia on the east, form a sort of *cul-de-sac*, into which the floes appear to be drifted about by winds and currents in a most erratic manner.

Mr. Markham states that the "ancient ice" 80 or 100 feet in thickness seen by Nares and other Arctic navigators is the result of "*slow accretions*," meaning, I presume thereby, that these great ice-masses are the gradual growth of a single floe by the freezings of many winters. My opinion is that this thick-ribbed ice is the result of extreme pressure, which has forced one floe over or under the other, as in the case of the upheaval of the Austrian ship with Weyprecht and Payer in 1873-4, of which mention has already been made in the columns of NATURE.

It is doubtful if the extremest cold of an Arctic winter would have any freezing influence on the lower surface of a floe 60 or 80 feet thick, only 9 or 12 feet of which was above water, whilst the remaining 50 or 68 feet were submerged. The known effect of the action of the sea in wasting away the submerged portions of icebergs, even when these are not large, tends to support the theory I suggest. J. RAE

4, Addison Gardens, W., November 5

A Photographic Experiment with Swan's Incandescent Light

SOME trials I have recently made with Swan's incandescent electric lamps give results that may possibly interest your readers. I employed throughout an electric stream of the same energy—that generated by thirty Grove cells, and as the whole experiment lasted but an hour, it may be assumed, for all practical purposes, that the strength of the current was uniform throughout.

I made use of four lamps in all, supplied promiscuously from Newcastle, their resistances being respectively: No. 1, 67 ohms; No. 2, 59 ohms; No. 3, 58 ohms; No. 4, 52 ohms. My object was to ascertain their actinic power upon a gelatino-bromide film, individually, collectively, and in groups. To do this I exposed a gelatino-bromide film to the action of one light at a distance of 14 feet, the sensitive film being placed behind a screen more or less transparent. The screen was divided into small squares, each representing different thicknesses of fine tissue paper. Thus: square marked No. 1 represented one thickness; No. 2, two thicknesses; No. 3, three thicknesses, and so on;

[1] The author says that Sir G. Nares ascended Smith Sound having a northern trending, but he does not tell us that both on the outward and homeward voyage he kept to the shore having an *eastern aspect*—a fact.

[2] The east coast of Greenland is an exception to this rule, being ice-encumbered by the force of a well known strong current pressing the floes against it.

the last square being almost opaque, and representing twenty-five thicknesses of tissue paper. The exposure in every case was ten seconds; the distance of the film from one light or lights always 14 feet, and the number of cells 30. The development was confined to two minutes exactly, an oxalate developer of normal strength being employed [1]:—

Result of First Experiment

		No. of square through which the light penetrated.
Group of four lamps	(Nos. 1, 2, 3, 4)	13
,, three ,,	(Nos. 2, 3, 4)	15
,, two ,,	(Nos. 3, 4)	19
,, one lamp	(No. 4, low resistance)	23
,, ,,	(No. 3, high resistance)	20

As it was a matter of difficulty to judge the exact square or number printed through, the mean results of three observers or readers was taken. So that the development should be the same throughout, all plates were developed simultaneously in the same dish.

The result may not permit us to estimate with scientific accuracy the value of the lights under *the above conditions*, but it proves practically (1) that the amount of light given off by four lamps is less than that given by three, and that the electricity is employed most economically for lighting when only one lamp is used; and (2) that, at any rate in the conditions described, a comparatively low-resistance lamp gives more light than a comparatively high one.

In my second experiment I estimated the actinic power of single lamps, when one or more were in circuit, the photographic arrangements being the same.

Result of Second Experiment

	No. of square through which the light penetrated.
One lamp, No. 4 (only one in circuit)	23
One lamp, No. 4 (two in circuit)	18
One lamp, No. 4 (three in circuit)	14
One lamp, No. 4 (four in circuit)	9
Arc light (with 30 cells) ... ... upwards of	25
Ordinary fish-tail burner (burning 5 cubic feet per hour)	7

The result here is interesting in showing the comparative strength of the lamps by themselves, and to what extent the light, so to speak, is "turned down" by bringing another lamp into circuit. As my screen was only graduated as far as 25, it was impossible to estimate the comparative value of the arc light, for it went above this degree, while a low-resistance Swan lamp only goes as far as 23. This last lamp, No. 4 in the series, was the one always tested, and therefore the results shown may be considered the most favourable. The result given by a good fish-tail burner permits us to make some comparison between gas and the Swan light at a minimum.

It says something for the skill with which the sensitive gelatino-bromide is prepared commercially nowadays, when we find it is so uniformly sensitive that in the two trials (where square 23 is recorded) there should be so unanimous a result.

November 12 H. BADEN PRITCHARD

Sound-producing Ants

REFERRING to Mr Blanford's letter in NATURE, vol. xxv. p. 32; whilst lying awake early one morning before the servants were stirring, when camped in the Deccan at the present small station of Chota or Chick-Soogoor, on the G.I.P. Railway, during the winter of 1868-69, I heard a sound, as Mr. Blanford suggests, repeated at regular intervals of about a second. It sounded as though the wall of the tent was being struck by a light fringe along one side; but noticing that the air was perfectly still, I listened for some minutes, wondering what it was and trying to fix the locality. I got out of bed cautiously and looked out; the whole of one side of the tent for a height of two feet was covered with white ants so thickly that at the first glance I thought the wall was covered with a grey-reddish mud to this height. I was trying to make out how the sound could be produced, when it stopped suddenly, the ants evidently having become aware of my presence; they then began to clear off the wall rapidly, and in a few moments it had become white again. They had not attacked the cotton wall. On looking at the ground round the tent I found their runs extending from a tamarind tope, the nearest trees of which were about 50 feet away. The runs were built in the usual way of red Deccan soil, there were great numbers of them, varying in width from the thickness of twine to 2½ inches, often crossing each other diagonally. No doubt the ants had found the tent in the evening, and were prepared to make a morning meal of a portion of it, when I disturbed them on looking out. The impression on my mind at the time was that the whole body of ants struck the tent wall at the same time with their heads, and that it was very extraordinary that they all stopped at once; there were no dropping shots, it was an instantaneous cessation along the whole line. The tent, which was a double one, was at least 30 feet long, and the ants possibly extended round the ends. JOHN FOTHERINGHAM

13, Springfield Road, N.W., November 12

[1] Developer:—
Saturated solution of oxalate of potash ... ... 3 parts.
Saturated solution of proto-sulphate of iron ... ... 1 part.

UNIVERSITY COLLEGE, LONDON.—The Calendar will give you all the information you want.

"FIFTY YEARS' WORK OF THE GEOGRAPHICAL SOCIETY."—We believe Mr. Markham's narrative may be ordered through any bookseller. The Polar Observing Station at Lady Franklin Bay was really occupied by a United States party in the past summer, with the intention of carrying on observations for at least a year.

SEALS IN LAKE BAIKAL.—Mr. Edward Fry refers Mr. Keane to Bell's "British Quadrupeds," 2nd edit. p. 248, where he will find that Herr Radde figures and describes the seal of Lake Baikal in his "Reise im Süden von Ost-Siberien"; and to Murray's "Geographical Distribution of Mammals," p. 126. Mr. Thomas Ward sends the following references:—Myer's "Geography, vol. ii. p. 9, edition 1829; Erman's "Travels in Siberia," vol. ii. p. 200 (Cooley's translation); "English Cyclopædia" (Article Baikal). From this last Mr. Ward quotes as follows:—"The existence of the salmon, of the seal, and of a kind of sponge in the fresh water of the Baikal has given rise to many speculations among naturalists. Pallas and Georgi are unable to explain this phenomenon otherwise than on the supposition that the Lake of Baikal at some remote period formed a part of the Northern Ocean, . . . or on another supposition, that these animals were transported into the lake by some excessive inundation of the Lena River, whose sources are not far from its western borders."

HEADS AND HATS

WE have received the following further communications on this subject:—

HAVING last March laid the subject referred to by your correspondents, Messrs. Kesteven and Hyde Clarke, before the Bristol Naturalists' Society in a short paper, I venture to offer a *résumé* of the facts collected by my friend Dr. Beddoe and myself, which seem to justify the conclusion that a diminished size of hat is now required by young men as compared with those used by the same classes twenty to twenty five years ago. (1) I have from time to time during the last three or four years had my attention called to this alleged change by Mr. R. Castle, hatter and hosier of 1, St. Augustine's Parade, Bristol, who, in proof of it, has frequently shown me hats of small size, such as are now generally required by both gentlemen and servants between the ages of twenty and thirty. He states that these smaller hats, which used to constitute only a small percentage of his stock, now form the bulk of it, whilst those which formerly suited the larger proportion of his customers are now usually required only by the older ones amongst them. Mr. Castle estimates the difference as amounting to at least one whole size, which is equivalent to three-eighths of an inch in circumference, and he has furnished me with typical extracts from his order book to Messrs. Lincoln and Bennett in fuller proof of his assertion. I have arranged and reduced his figures in the accompanying table, and the result does undoubtedly seem to be that the buyers of 1875-80 are taking a hat at least one size smaller than the same *class* (not necessarily the same individuals) used to do twenty to twenty-five years previously. (2) My friend Dr. Beddoe, whose attention I called to the subject last year, informed me that Mr. C. Garlick, hat manufacturer of 87, Castle Street, Bristol, furnished him with the sizes of 200 hats sold by him in 1862, and the average is precisely 7, one of the lots yielding 7·01 and the other 6·99. Two

Orders for Hats from Messrs. Lincoln and Bennett in 1855, 1875, 1878, *and* 1881

Sizes.	$6\frac{1}{2}$	$6\frac{5}{8}$	$6\frac{3}{4}$	$6\frac{7}{8}$	7	$7\frac{1}{8}$	$7\frac{1}{4}$	$7\frac{3}{8}$	$7\frac{1}{2}$	Total.	Avge.		Remarks.
Circumference.	$20\frac{1}{2}$ in.	$20\frac{7}{8}$	$21\frac{1}{4}$	$21\frac{5}{8}$	22	$22\frac{3}{8}$	$22\frac{3}{4}$	$23\frac{1}{8}$	$23\frac{1}{2}$	No.	Size.		
1855		1	2	4	4	4	4	2	1	22	$7\frac{1}{16}$	$7\frac{1}{20}$	
,,				4	3	3	2			12	$7\frac{1}{32}$		
1875		2	4	6	6	4	2			24	$6\frac{30}{32}$		Average shrinkage about $\frac{1}{7}$ ('014), or rather more than one size, which amounts to $\frac{1}{8}$. Circumference of head diminished by nearly $\frac{1}{2}$ an inch.
,,		1	3	2	3	2	1			12	$6\frac{29\frac{2}{3}}{32}$		
1878		1	3	8	4	6	2			24	$6\frac{30\frac{5}{6}}{32}$	$6\frac{29}{32}$	
,,	1	3	3	3	1	1				12	$6\frac{25}{32}$		
1880		1	4	4	2	1				12	$6\frac{27\frac{1}{3}}{32}$		
,,	1	6	3	6	5	2	1			24	$6\frac{27}{32}$		These are all livery hats and are excluded from the averages.

lots of 100 each sold by him in 1880 averaged respectively 6·89 and 6·92, or a mean of 6·905. Thus the shrinkage since 1862 appears to be about 0·1 of the technical scale usually employed by the trade, of which 0·125 ($\frac{1}{8}$) represent a difference of *one size*, but a difference in the *circumference of the head* of $\frac{3}{8}$ths (= 0·375) of an inch. Therefore the above 0·1 deduced by Dr. Beddoe from Mr. Garlick's figures represents a shrinkage in circumference of over $\frac{1}{4}$ of an inch, which agrees pretty closely with my previous result of "nearly $\frac{1}{2}$ an inch" from Mr. Castle's data. (3) While in Scotland during the summer of 1880, Dr. Beddoe learned from the principal hatter in Glasgow that his experience fully corroborated what has been stated, so that the diminution appears not to be confined to the southern portion of the kingdom. (4) Mr. Mordey, hat manufacturer, of 159, Blackfriars Road, London, wrote me on February 22 as follows:—"In answer to your inquiry I beg to say that my experience tells me that men's heads have decreased in size during the last twenty years. Twenty years ago the circumference of men's heads ran from $21\frac{1}{4}$ to $23\frac{5}{8}$ inches. At the present time the size is from 21 to $22\frac{3}{4}$—mostly 21 to $22\frac{3}{8}$. This decrease is so general that we do not make big sized hats for stock, but only as ordered, and very few then." (5) Another hat manufacturer writes:—"Fifteen years ago the usual sizes of hats in England were from $6\frac{3}{4}$ to $7\frac{3}{8}$, and even $7\frac{1}{2}$ was not uncommon. But now if a $7\frac{3}{8}$ hat were wanted we should have to make a block purposely." This may be sufficient evidence to show the probable accuracy of those who assert the fact of shrinkage in the size of hats, and it only remains to add a few words as to the possible cause. To the somewhat obvious suggestion that the practice of wearing the hair more closely cropped might account for the difference, Mr. Castle, as a practical hatter, replies that the effect of this would be scarcely perceptible, and further urges that the less the head is protected by a cushion of hair, the easier must be the fit of the hat, to prevent friction and ensure comfort. The same view is taken by the manufacturer quoted in paragraph (5), who writes, "this solution of the matter is inadmissible." Another suggestion is that the mode of wearing hats has changed, and the present style admits of a smaller size. On this point Mr. J. C. Withers, hat manufacturer, of 80 and 81, Castle Street, Bristol, who has been in the trade upwards of thirty years, writes as follows:—"I am well aware that the size has considerably decreased within the last twenty to twenty-five years, but I attribute this entirely to the manner in which they are now worn, which is far more forward on the head than formerly. If I were to wear my hat as my grandfather did I should take one quite a size larger. When I was first at the trade I well remember that all hats had a cloth patch sewn on the under side of the brim at the back for the purpose of taking the friction off the coat collar, and thirty-five years ago we never made a hat without one." This explanation, I confess, sounds plausible; but though I well remember the cloth patch, so far as my memory serves it scarcely seems to me that the mode of wearing the hat has sufficiently changed within the interval (fifteen to twenty-five years) stated by the various authorities quoted to be adopted as offering a solution of the problem. In *Public Opinion* for May 28, 1881, is a letter on the subject signed "F. J.," which concludes thus: "This really does not account for the change, as hatters can testify. Twenty-five years have made little difference in the way of wearing hats, and it is during the last twenty-five years that the change has taken place." By Dr. Beddoe's kind permission I am enabled to add a curious list of the sizes of hats worn by several eminent men, which was sent to him by Mr. Garlick, who obtained it from a friend in London:—

Lord Chelmsford ..	$6\frac{1}{2}$ full.	Earl Russell	$7\frac{1}{4}$
Dean Stanley	$6\frac{3}{4}$	Lord Macaulay ...	$7\frac{3}{8}$
Lord Beaconsfield ...	7	Mr. Gladstone ...	$7\frac{3}{8}$
H.R.H. the Prince of Wales	7 full.	Mr. Thackeray ...	$7\frac{5}{8}$
Charles Dickens ...	$7\frac{1}{8}$	Louis Philippe ...	$7\frac{3}{4}$
Lord Selborne ...	$7\frac{1}{8}$	M. Julien[1]	$7\frac{3}{4}$
John Bright	$7\frac{1}{8}$	Archbishop of York	8 full.

In conclusion, to quote the remarks on my paper of a writer in the *Bristol Daily Press*, "In future the familiar expression, borrowed from Milton, of an opponent 'hiding his diminished head,' will possess a special significance. Fuller alludes, in his dissertation on 'Natural Fools,' to persons whose heads are 'sometimes so little that there is no room for wit, and sometimes so long that there is no wit for so much room,' so that, possibly, a slight diminution in the cranium is not an unmixed evil. There is, at any rate, no marked deterioration in the mental faculties, so critics may still find themselves in the position of the rustics who gazed in wonder at Goldsmith's village parson—

> "'And still they gazed, and still the wonder grew
> How one small head could carry all he knew.'"

If the diminution of heads, as well as of hats, be established, does it imply a diminution of the amount of brain, or only of the size of the cranium? F. F. TUCKETT

Frenchay, near Bristol, November 12

I BELIEVE that hatters' measurements of the head can only be accepted as mere records of the change of fashion, and that they are of little anthropological value. Thirty years ago close cropping of the hair was confined almost entirely to soldiers, grooms, and prisoners, and it was popularly considered a badge of servitude, or worse; but now, thanks perhaps to the Volunteer movement, and to the discontinuance of hair-cutting as a punishment in prisons, the military style of wearing the hair is almost universal among young men; hence smaller hats are required now than formerly. I find that long and short hair make a difference in the circumference of some heads of nearly half an inch. Again, our nightcap-wearing fathers and grandfathers were very much concerned about the temperature of their heads and ears, and they were accustomed to press their hats well down to keep them warm. Now they are worn much higher on the head, as a glance into any old print-shop window will show. Travelling-caps, and caps worn by boys, were formerly provided with lappets to cover the ears, but these peculiarities have long since disappeared, and caps of an undress military character, or felt hats, stuck on the *top* of the head, have taken their place. Mr. Hyde Clarke, in his letter in your last week's issue (p. 32), says that he has observed that the ears are lower down now than formerly, and he thinks this a proof of degeneracy of race; but the ears only appear lower because the hats are higher on the heads, and in any case it could be no proof of degeneracy, because the lower the ear the bigger the brain. But the chief reason for the falling off in the dimensions of hats in the present day is the accession to the hat-wearing community of a very large number of small-headed persons, such as clerks and shopmen, who formerly did not wear hats at all; and, on the other hand, the defection of a large-headed class, the clergy, who have given up tall hats and taken to the use of soft felt ones. The only way hatters' measurements could be made available for anthropological purposes would be to examine the statistics of one class, say the professional, who have always worn hats, and then allow for the change of fashion in the hair and the position of the hat at the present day. If it is really the case that the heads of the present generation are smaller than those of the last, we must look for the cause, not in tight-lacing, but in the diminished size or the deformity of the female pelvis, for it is this which is the gauge of the heads of the people. Male infants are longer, heavier, and have longer heads than females, and at the time of birth a greater destruction of males takes place in consequence. In Europe the proportion of infants born alive is 105 males to 100 females; but if we include the stillbirths, the proportion of the sexes is 150 males to 100 females, showing that there is a sad loss of some of the finest physical and probably mental products of our race by the mere mechanical

[1] A most remarkable head, $7\frac{3}{4}$ × $7\frac{3}{4}$.

difficulties at the time of birth. There can be no doubt that rickety conditions of town children, and the sedentary or persistent standing occupations of young girls in shops, &c., will tend to distort the pelvis, and thus act injuriously on the race by reducing both the physical and mental standard of their children. With regard to the progressive degeneracy of our population referred to by Mr. Hyde Clarke, I think something more definite than personal recollections is required to prove it. We all know how we are daily compelled to recognise the fallacy of our earlier recollections. If we go down to a country town or village, which we knew well a few years ago, we find the houses smaller, the streets narrower, and the whole place shrunken in its proportions, and it would be the same with the inhabitants also if they had stood still as the inanimate objects have done around them. There can be no doubt that our large towns are, as it were, the graves of the physique of our race, but it is not because town life is so very injurious, but because the feeble, the halt, and the blind gravitate towards them in search of work suitable to their capacities. So far from admitting the degeneracy of our population as a whole, I am satisfied that it is improving in physique, and is better now than at any former period of our history. The skill and care which saves the weak child to the community, gives health and strength to the strong, and the physique of the whole is raised to a higher level. It is difficult to find direct evidence of this improvement, but some statistics of the stature and weight of factory children (where we might expect degeneracy if anywhere), recorded in 1833 and in 1873, show that the children of the latter period were a whole year in advance of the former—children of ten or eleven years of age in 1873 being as tall and heavy as those of eleven and twelve fifty years previously. CHARLES ROBERTS

Bolton Row, Mayfair, November 11

IN a letter on the above subject in NATURE, vol. xxv. p. 8, Dr. W. B. Kesteven asks for information or opinions on the statement that English heads have diminished in size during the last twenty-five or thirty years. My own opinion is that this is really the case. On the cause of this diminution I am not at present prepared to give a decided opinion. In the course of some investigations on heredity, commenced many years ago, I discovered that in some instances the average size of the heads of the sons and daughters was less than the average of those of the two parents. In each case the former had arrived at maturity before the comparison was made, and in every instance the children had had the advantage of a much larger amount of intellectual training than the parents had enjoyed. This discovery, so contrary to all the generally accepted opinions, surprised me considerably, and caused me to make inquiries from one of the leading hat-makers in this city as to what had been his experience in the increase or diminution in the sizes of hats sold. The facts furnished to me fully confirm the statements made in Dr. Kesteven's letter, and as the hat manufacturer to whom I refer has been more than forty-five years in the business he has had ample opportunity for collecting trustworthy information. From an article subsequently published by him in a trade journal (*Umbrella and Portmanteau Trades Review*, July, 1880) I take the following: "There is another feature in connection with heads which is singular in this district, and that is the decrease in sizes. It used to be considered sufficient to make one to each dozen; we now make, on an average, three or four of these sizes, which we are now obliged to keep in stock to meet our requirements. I allude to such sizes as $6\frac{1}{2}$ and $6\frac{5}{8}$, which formerly were only necessary in boys' hats. This decrease in the size of heads has been going on for the last twenty-five years to my certain knowledge." In the letter appended to Dr. Kesteven's letter Prof. Flower asks the important question, "Does it [the statement] refer to any particular class of men, and does it refer to the same class of men?" In answer to this I have to say that the classes to which the figures in my quotation refer are, and have always been, much the same, namely, the upper and middle classes; and the individuals included in these two classes have had as much variety in their occupations as any large city, such as Manchester, can furnish. Another important question is also asked by Prof. Flower, namely, "May it (the decrease in the size of hat) not arise from some change of fashion, . . . such as hats being worn more on the top of the head than formerly." In some few instances this might possibly account for the difference, but in the majority of cases, and especially in those belonging to the dolichocephalic class of heads, it will be found that it requires quite as large a size of hat when worn more on the back part of the head as it does when worn on the top. The data already collected are probably not sufficient to base any settled opinion upon; but if more extended investigation should confirm the statements made above, it will then be a matter of some importance to us to endeavour to discover the cause of this diminution in the size of English heads. It will also be interesting to know if any such phenomenon has occurred in any other country.

Old Trafford, Manchester CHARLES H. BLACKLEY

SURELY Mr. Hyde Clarke's arguments in favour of the hatters' statements are somewhat defective. Even if the survival of human weaklings be granted, it by no means follows that a being with a weakly body must needs have a small head. Indeed the exact converse is usually accepted; for big-chested athletes are generally supposed to be the men in possession of the smaller heads, and persons of weakly constitution the possessors of the larger heads. A weakly condition of body and health is often associated with great mental activity. Besides, at birth, the conditions, if favourable for the survival of weaklings, are surely equally favourable for the strong and well-made; under ordinary circumstances then these latter individuals should show an increase in the size of the head. It cannot be imagined that the weaklings are surviving at the expense of the strong and hearty, such a case would be, as some one has said, a survival of the unfittest. It would be interesting if Mr. Hyde Clarke would tell us something more about the "old standard" in ears, when he observed ears begin to fall below this old standard, and how the old standard in ears is to be recognised. My business as an artist has caused me to particularly notice heads and faces for many years past, and from ten to thirty portraits (old and new) pass through my hands every week. My opinion, founded on this experience, entirely agrees with the statements made by some of the speakers at the meeting of the Anthropological Institute mentioned by Mr. Clarke. The alleged diminution in size of men's heads is I think due to a misinterpretation on the part of the hatters of the fact that the hair is worn much shorter now than formerly, and the hat is now worn more on the crown of the head than in the past generation. The brim of the hat brought close down over the brows and the long hair in men is a very marked feature in old portraits. W. G. SMITH

125, Grosvenor Road, Highbury, N.

I SHALL not enter into the question of the relative sizes of the heads of our generation and of that of our fathers or grandfathers, beyond stating my general agreement with the explanation suggested by Prof. Flower, viz. that we carry our hats perched on the top of our heads instead of bringing them down as they did over occiput and ears, and that many of us, myself included, wear what hair we have so short that brushes and combs become superfluities. But I must express my surprise at so eminent a reasoner and statistician as Dr. Hyde Clark giving his support to a notion that to every medical statist seems a transparent fallacy—that a reduced infant mortality implies a deterioration of the race. If the deaths of children were owing solely to exposure to the elements, there might be a survival of the fittest, and such was the case among the Highlanders in former days, as it is perhaps still among Red Indians and the like; but we know that disease does not strike or weed out the feeble ones, or the people of Liverpool and Manchester, among whom 60 to 70 per cent. die before attaining their fifth year, ought to be a more stalwart race than the Scandinavians, who lose only about 16. No! infant mortality in civilised (?) and urban populations is due to two great causes, zymotic diseases and parental neglect, including insanitary surroundings. Now scarlatina, diphtheria, &c., do not show any preference, but cut off healthy and weakly alike; and improper food, foul air, overcrowding, bad drainage, though they may kill the feebler outright, tend to deteriorate the survivors; the weak die, the strong are made weak; those who do not die of scrofula, or diarrhœa, or rickets in infancy grow up puny or consumptive—"Mox daturos progeniem vitiosorem." I maintain that just as each death registered represents two whole years of sickness, so each infant's life saved implies two who would have been feeble rendered healthy and valuable members of society. The opposite view would strike at the root of all sanitary reform.

76, Marquess Road, N. EDWARD F. WILLOUGHBY

MONO ISLAND, TRINIDAD

THE following extract from the log of the R.Y.S. *Northumbria* has been sent us for publication by Dr. G. H. Kingsley; it is dated February 28, 1881:—

"An almost perfectly land-locked harbour is formed by Monos itself and the neighbouring islands; on the Monos side indented with little bays, each one with its pretty white cottage, sparkling in the shade of clumps of coco-palms, with a silk cotton tree here and there, the latter looking as if they were trying to grow themselves into boards to save the sawyer trouble. The general tone of the vegetation just now is rather dull and New Zealandish, but the rocks along shore are covered with an infinity of bright flowers and shrubs, slender-shaped aloes bearing golden blossoms on their candelabra-like branchlets; wild pines with pink bracts and bright yellow petals, with sweet-scented orchids dangling anywhere and everywhere.

"*February* 29.—From Morrison's Bay in the hot level morning sun (most punishing and dangerous of all are the point-blank darts of Apollo), fairly into the Bocca Mono, upon the mysterious 'Guacharo,' which is here called 'watchelo.' The only cave containing them accessible at present was a low-browed one at the base of the cliff, into which an occasional roller sweeps ever and again in a most unpleasant manner, lighting up the black interior with flashes of foam, which augurs badly for the safety of our delicate pine gig. On this it was thought better to fall back on native talent, fishing close by in an island boat formed as to its lower parts of a 'dug-out' from the solid tree, and as to its upper of two planks nailed on to heighten the free board. A tituppy, ticklish kind of a craft to the inexperienced, crank in the extreme, but with a huge reputation for seaworthiness when properly handled. The negro proprietor had his head tied up in a dirty clout, in consequence of a difference of opinion with another 'cullud gebblum,' who had revenged his broken nose by literally 'mashing him jaw with rock-stone.' Though mumbly in speech, he was civil and accommodating, and taking Morrison and L. on board his dancing walnut-shell, he backed into the cave on the back of an accommodating wave. The cave was not deep enough to prevent the proceedings of those within being seen and heard by those without, and soon dismal yells, followed by smoky and smothered explosions, showed that hints were being given to the 'watchelo' to show themselves to their visitors. Another shot, followed by a jubilant shout, told us that one at least had shown himself once too often, and the party emerged blinking into the sunlight with their prey. The second entry was like the first: the interior commonplace and cavey, the interesting thing, of course, the 'watchelos,' fluttering about and perching on the more prominent projections. It is a remarkably handsome, upstanding, and even graceful bird, long-tailed, brown-feathered, with white diamond markings, just the colour of the quartz crystals in the reddish-brown rock on which it stood—a capital instance of preservative colouring, or the effect of surrounding colour. Altogether the 'watchelo' looks very much like a cross between the long-tailed cuckoo and a fair sized hawk; though the thighs are quite bare of feathers. We have been told all that is known about these queer fruit-eating Fissirostres—still there is much that is not known; for example, where they spend the night in collecting the fruit which contains the hard bristly seeds found in the stomachs of the adults and the young, and which, developing their nestlings into mere masses of fat, render them, as charming Mrs. Morrison says, '*si bon à manger.*' Mr. Morrison says that they feed on the '*Tierra firma*,' or mainland, but even he knoweth not on what.

"Having finished thus successfully our chase of the frugivorous goatsucker, we turned our attention and boat's head to another cave on the other side of the Bocca, in which dwelt an equally eccentric and out-of-the-way animal, the 'piscivorous bat.' These queer creatures, possibly in imitation of their opposite neighbours, have relinquished their supposed natural food, and have betaken themselves to catching fish at night in a manner which is not very clearly made out. Either they scoop them off the surface of the water by means of the membrane extended between their hind legs, or they catch them with their exceedingly sharp and curiously arranged claws. They dwell in a cave much more lowly and commonplace than their neighbours the 'watchelos,' and as they declined to answer the invitation sent to them by a shot into its interior, some of the party jumped overboard, mid-leg into the water, and proceeded with shouts and yells to drive them out into the glaring sunlight. Out they came in scores, these odd members of the Fishmongers' Company, flickering and fluttering in the slanting morning rays that shone through their diaphanous wing membranes and almost translucent chestnut-coloured bodies. Gnomes, Fays, Fanfullas, Flibbertigibbets, any queer, fantastic thing you have ever fancied or dreamt about, were not half so fantastic as these! Strange, and not without weird beauty to the eye. But to the nose! Fairylike in form and fluttering as they might be, the simple truth is they stank like Fitchets! 'Ruddy Miss Prue with golden hair,' in her wildest rompings, was nothing to them, and the scent produced in the hardest and strongest 'illiad' mariner a fervent desire to heave up his immortal soul. Possibly in revenge for this, the hardy one went for them with a boat-stretcher with such enthusiasm that shortly a hollow sound was heard, and another mariner, no longer enthusiastic, was observed banging his head over the gunwale of the boat, with the blood trickling down his innocent nose from as pretty a scalp-wound as ever delighted a savage. However, but little harm was done, and we collected our wounded and slain, many of which had meanwhile sunk to the bottom, and wended our way back to the *Northumbria*.

"We visited the Bocca again in a late twilight, if there be such between the tropics, to study the mode of fishing of these most mysterious bats; but it was too dark to make anything out with certainty, though the queer scooping 'swish' supposed to be produced by their skimming the surface of the water with their posterior membranes, was distinct enough. What was even more distinct was, not to put too fine a point upon it, the stink; even right out in the open Bocca and at some distance from the cave, we were aware of the neighbourhood of individuals by the heavy rank smell floated towards us in the hot evening breeze.

"It is not the slightest use the 'parlour naturalists,' who study birds in glass cases and fishes in bottles, saying that this bat, from its 'dentition,' 'tripetition,' or any other of its 'itions,' must be frugivorous or insectivorous. The simple fact is that it is neither. When you find an individual of showy exterior, but slightly imperfect manners, with his pockets full of watches with the swivels broken off, you are justified in classing him, without the slightest reference to his 'dentition,' as a specimen of the 'swell mob—Homo watch-priggious'; and I maintain that when you find the stomach of a bat—the only pocket he possesses, not being a marsupial—stuffed with the scales and bones of fishes, you are fairly entitled to put him down as 'ichthyophagous' by all the rules of common sense. Our queer friend the 'watchelo,' with his deeply-cleft bill and outstanding bristles, *ought* to be a moth-catching goatsucker; but unless he swallows seeds for ballast he certainly lives on the fruits which contained them. It is the old story: directly we find what we call 'Nature' doing a thing perfectly well in one way, we immediately find her doing it equally well in another and directly opposite one. If she finds a bird with a bill perfectly formed for the catching of moths, she at once shows that it will do equally well for picking fruits off the bushes on dark nights; and if a bat can take the smallest midge in the twilight with unerring accuracy, she turns him without alteration into as good a fisher as the very otter himself.

"I am sorry to say that the 'fish booming and drumming,' described by Charles Kingsley, was not to be heard. Either we were there at the wrong season, or the fish had been driven away by the use of dynamite. From all I heard, the sound was identical with that produced by the drum-fish so common in the Indian river of Hinda."

ROBERT MALLET, F.R.S.

THIS eminent engineer, whose researches on earthquakes are so well known to scientific men, died on the 5th inst. at the age of seventy-one. During his very active career he accomplished a vast amount of work, of which his "Earthquake Catalogue" and other published books and memoirs form the best monument.

Robert Mallet was born in Dublin on June 3, 1810. He was descended from the representative of a Devonshire family who had settled in Ireland, his father being the owner and manager of an engineer's factory. During childhood Robert Mallet appeared to be of weakly constitution, but he grew up to be a man with great powers of endurance. His taste for science was exhibited at a very early period, and before he had reached the age of twelve years he had established a laboratory in his father's house, where he delighted in performing chemical experiments. After being taught in a private school in Dublin, and making a tour on the Continent, he entered as a student at Trinity College, Dublin, and in 1830 completed his studies there by taking his M.A. degree. In 1831 he made an extended tour on the Continent, and, upon his return, married, and entered into partnership with his father. From this time forth he was busily engaged in various engineering projects both in the capital and in various parts of Ireland. Private study and research were, however, by no means neglected during these busy times, and in the very year of his commencing business we find him publishing his first paper on the motion of glaciers. He had before this time been elected a member of the Royal Irish Academy. In 1839 Mallet was elected a member of the Institute of Civil Engineers, and in the same year made his important invention of "buckled plates," an invention which was not patented till 1852, the patent being prolonged in 1866. It was in 1846 that Mallet published his first paper on Earthquake Phenomena; this memoir, which appeared in the *Philosophical Magazine*, gave a simple explanation of the supposed "vorticose movements" during earthquakes, and two years later a paper in the *Transactions* of the Royal Irish Academy contained a full exposition of his views on the wave-movement in earthquakes, with which every one is now familiar. During subsequent years Mallet published in the British Association Reports his papers, which aimed at drawing up a complete catalogue of earthquakes, with various contributions to seismology and seismometry. In 1857 occurred the great earthquake in the Neapolitan territory, and in the following year Mr. Mallet was commissioned by the Royal Society to proceed to the district and to study its effects.

The results of his observations were published in two volumes in 1862. In 1858 the Earthquake Catalogue was completed by Robert Mallet with the aid of his son, now Prof. J. W. Mallet of Virginia. About this time we find Mallet engaged in experiments upon artillery, and in calling attention to a new gun which he had invented, but which never seems to have been of much practical utility. In 1872 Mallet laid before the Royal Society a memoir, to which he had evidently, during many years, devoted much time and labour; it was entitled "On Volcanic Energy, an Attempt to Develop its True Nature and Cosmical Relations."

Whatever differences of opinion may be entertained as to the truth of the theory which is there sought to be established, there can be none whatever as to the value of the experiments which constitute its basis, or of the important influence which it has exercised upon geological thought and speculation. This important memoir, which was published in the *Philosophical Transactions*, has been translated into German by Prof. von Lasaulx, who has added a valuable commentary to it.

During the later years of his life, Mallet, who had removed from Dublin to London, was afflicted with almost total blindness, but he nevertheless continued to make occasional contributions to his favourite branches of science. Altogether he was the author of more than seventy memoirs, besides separately published works. Mr. Mallet was elected a Fellow of the Royal Society in 1854 and of the Geological Society in 1859; in 1877 he was awarded the Wollaston medal of the latter society.

THE LAND OF THE MIDNIGHT SUN[1]

UNDER the above striking title we have an account of the Peninsula of Scandinavia and of the life of its people, based on a series of journeys made at different times from 1871 to 1878, by Mr. Paul Du Chaillu. It is pleasant to meet with an author, already so well known for his travels in Equatorial Africa on new ground, and to find that his journeyings on virgin soil and among wild and savage races have not unfitted him for the study of the physical characteristics of an old country, and of the manners and customs of its inhabitants. The reader of these two handsome and well-illustrated volumes may form some notion of the extent of ground traversed during a five-years' sojourn, from the tracings of the author's routes on the map appended to the first volume. Not only was the country travelled over from north to south and from east to west, but the coast-line from Haparanda to the extreme north-eastern point of Norway, a distance of 3200 miles, was observed, the greater part of it both in winter and in summer, and over 3000 miles of fjords were sailed along. The illustrations are most frequently from photographs, but those representing Lapland winter scenes are the work of a Swedish artist.

A great many pages of this work, while pleasant reading, will not afford much new information to the reader who may have already travelled in Sweden or Norway. The route from London to Göteborg, Stockholm with its beautiful suburbs, Upsala, Christiania, Bergen, the Dovrefeld, the splendid scenes of the Romsdal; these and a few more well-known routes and places are all within the compass of an ordinary summer's tour; but Du Chaillu has told of these all in an attractive and appreciative manner, and he treats of many such only by the way as he journeys on to places seldom visited even by the sportsman in pursuit of game. He gives a good deal of interesting information about the Laplanders. The Lapps are described as kind-hearted, dirty people. Their life during summer is a very hard one. They have to follow their reindeer day and night, lest the herds should wander. Coffee was their principal drink, mixed with the thick reindeer's milk. They were a fair-haired and fair-skinned people, with blue eyes, prominent cheek-bones, and the nose *retroussé*. The men were from four feet five to five feet and one-quarter inch in height, and three women measured four feet and one-quarter, four feet and three-quarters, and four feet six and three-quarters of an inch in height respectively. It was at the Lapp village of Jockmock that Prof. Baron von Düben, so well known and appreciated in this country for his writings, was met with. He was engaged in the study of the Lapps when Du Chaillu, fatigued and hungry, found himself entering the station. Longing to see a human

[1] "The Land of the Midnight Sun: Summer and Winter Journeys through Sweden, Norway, Lapland, and Northern Finland. With Descriptions of the Inner Life of the People, their Manners and Customs, the Primitive Antiquities, &c." By Paul B. Du Chaillu. In two volumes, with map and 235 illustrations. (London: John Murray, 1881.)

face, he saw the Professor approach; and although he had never before met him, he addressed him correctly at once. He brought Du Chaillu to the neighbouring parsonage; food was soon before him, and a hearty welcome. We incidentally learn that several of the illustrations of Lapland which accompany this narrative are from original photographs taken by the talented wife of the Baron.

A Laplander's encampment would not seem to be a savoury place. A Lapp tent at its base is scarcely more than eight feet in diameter; it is very portable. The frame is composed of poles fitting into each other, easily put together, and so strong and well knit that they can resist the pressure of the heaviest storm. A cross-pole high up sustains an iron chain, at the end of which is a hook to hold kettles. Over the frame is drawn a cloth of coarse wool called "vadmal," made by the Laplanders, who never use skins; this is composed of two pieces, and is made fast by strings and pins, and well secured. A small door of canvas is suspended over the entrance. Such a tent will last more than twenty years. Some idea of its form can be obtained from the accompanying illustration. Such tents, when removed in winter, are drawn by reindeer in sledges, but in summer they have to be carried on the backs of the reindeer. Hence the moving of a Lapp encampment in summer is a very much more difficult undertaking than in winter.

The chapter on the vegetation within the Arctic circle is disappointingly short. There for some weeks there is little interruption to vegetation. What in these countries of midnight darkness can only be attempted by the aid of a brilliant electric light, is in those countries of midnight light brought about in a less artificial way. Rye planted at the middle of June was seven or eight feet high early in August, growing after first germination at the rate of three inches a day. The barley at Niavi was ready for the harvest six or seven weeks after being sown. Agricultural schools were met with all through Norway and

A Lapp Tent.

Sweden. These schools seem already to have been of enormous value to the country, raising the standard of agriculture and keeping the students up with the march of progress.

A second visit to Lapland—this time in midwinter—is described in Volume II. Entering a forest after a long drive, the author found himself suddenly in the midst of a number of holes several feet deep, dug by reindeer. Several thousand reindeer had evidently been at work. The snow was not very deep—not over four feet. Under that cover was buried the moss of which the reindeer is so fond. All except the younger ones were busy digging, first with one fore-foot, then with the other, the holes gradually becoming larger and larger, and the bodies of the animals more and more hidden. They would never stop excavating till they had reached the moss. Wherever one turned their eyes the reindeer were doing the same work, for they were evidently hungry. Their number seemed countless. Some had dug these holes so deep that nothing save the tails of the reindeer could be seen swaying to and fro outside of them.

The following extract, referring to the tame reindeer, will be read with interest:—

"Late in April and early in May is the reindeers' calving season; the period of gestation is thirty-three weeks: the little ones are either carried or put into a sleigh. When the reindeer cows call for their young they utter a peculiar grunt, which is answered by the calves. Many of the animals had already dropped their horns. The large ones resembled those of stags, but they are smaller: the reindeer is clumsier than the deer, with stouter limbs, shorter head, and a larger and wider muzzle, more like that of a cow; the hoofs are broader and much larger. The hair is grey, very coarse and thick, especially in winter, and sometimes two inches in length; the colour is much darker on the back, and almost white under the belly; the young are lighter-lined than the adults. The colour often varies considerably

among different herds, and frequently by this the ownership can be known. The reindeer are never housed, for they like cold weather and snow. Food is never given them, and they will not touch the moss that has been gathered, unless brought up to do so. They often will not even raise their heads as you approach them, and remain quiet when the Lapps pitch their tents, as we have seen. Some years prove unfavourable to their increase, on account of the amount of snow, which prevents them from digging for food; the herd then becomes weak and emaciated, and many die. The spring is also a bad time for them; the snow melts during the day, and a thick crust forms at night, so that their feet break through, causing lameness and disease. The horns of the males, which often weigh forty pounds, attain the full size at the age of five or six years, those of the cow at about four years. The time of dropping the horns in a herd varies from March to May; in the adult animal they attain their full size in September or at the beginning of October. After the age of eight years the branches gradually drop off. The shoulder-blades appear a little high, occasioning a slight hump or protuberance. Without the reindeer the Laplander could not exist in those northern regions: it is his horse, his beast of burden; it affords him food, clothing, shoes, and gloves. Domestic reindeer are a curious admixture of wildness and tameness. In some respects they are greatly superior to other cattle; in a herd they are very easily managed; they usually keep close together, and in the winter season remain where they have been left to feed. When on the march, with the help of dogs, they go in a solid mass, and a herd does not scatter unless wolves are after them; but in summer they often wander a long distance when left by themselves, as is often the case. When harnessed they become uneasy and distrustful, and great caution has to be taken not to startle them. Often trained reindeer, like horses, become refractory or vicious, and very difficult to manage, and then the Lapp shows his skill. The speed of the reindeer varies very much according to the time of the year, October, November, and December being the months in which they are fleetest, as then they are fresh from their summer pasture; the cold weather strengthens them, and they are not exhausted from digging the snow, not yet very deep, to procure their food. The rapidity of their gait depends much on the state of the surface. If this is well packed or crusted, and if previous furrows have been made, they go very fast. Much depends too upon the distance, and whether the country is hilly or not, with a long range of slopes. On the rivers, over well-packed snow and a good track, the animals can go twelve or fifteen miles the first hour, and down a long mountain-slope twenty miles, and even more. They can travel five or six hours without stopping, the first hour rapidly, the second more slowly, and towards the fifth or sixth quite slowly, for by that time they require rest and food. Early in the winter, when they are in good condition, one can travel with a swift reindeer one hundred and fifty miles in a day, where the country is not very hilly and the way good, and easily enough one hundred miles. The colder the weather the greater is the speed: seventy or eighty miles is a good average, but they were slow at the season of which I write."

Reindeer digging in the snow.

The chapter on the Lofoden Islands gives a great deal of information about the extensive fisheries of cod, in which over 700 fishing-boats are employed.

We had marked several other extracts relating to the domestic life of the Norwegian peasants in the high north, and to the interesting people of Dalecarlia; but enough has been given to show our readers that, while the narrative of these travels is free from the exciting scenes witnessed in Gorilla Land, it is not wanting in much that will be read with pleasure and remembered with profit.

NOTES

We take the following from the *Times*:—The medals in the gift of the Royal Society for the present year have been awarded by the Council as follows:—The Copley medal to Prof. Karl Adolph Wurtz of Paris, For. Mem. R.S., for his discovery of the organic ammonias, the glycols, and numerous other investigations which have exercised considerable influence on the progress of chemistry; the Davey medal to Prof. Adolf Baeyer of Munich for his synthesis of indigo; a Royal medal to Mr. Francis Maitland Balfour, F.R.S., of Cambridge, for his numerous and important contributions to animal morphology, and more especially for his investigations respecting the origin of the uro-genital organs and the cerebro-spinal nerves of the vertebrata, and for his work on the development of the elasmobranch fishes; a Royal medal to the Rev. John Hewitt Jellett of

Dublin for his various mathematical and physical papers, more especially for his researches in chemical optics and his invention of the new and delicate analyser by which they were carried out.

THE Bakerian Lecture at the Royal Society will be given next Thursday by Prof. Tyndall, on the "Action of Free Molecules on Radiant Heat, and its Conversion thereby into Sound."

THE election to the Linacre Professorship of Physiology in Oxford University will take place on the 25th inst.

M. PAUL BERT, the eminent Professor of Physiology at the Sorbonne, has been appointed French Minister of Public Instruction by M. Gambetta. Two hours only after his nomination had been signed by the President of the Republic he read before the Academy of Sciences an elaborate paper on "Chloroform and other Anæsthetics." This may be considered as a token of the interest that the new French Government mean to take in scientific matters. M. Cochéry, of the Post and Telegraph Department, is the only member of the old Cabinet who has taken office in the new one.

IN view of the great and kindly interest the United States have always taken in English Arctic expeditions, the Council of the Geographical Society have determined to urge H.M.'s Government to undertake an expedition next year in search of the *Jeannette*. It being obviously more easy for the Americans than for this country to send an expedition by sea on the side of Behring Strait, it is thought that it would be best to despatch a party along the Great Mackenzie River to search the coast-line that can be reached from it, and that such work might most advantageously be carried out through the agency of the Hudson Bay Company. Under these circumstances it will be necessary to open communications with the Colonial Office on the subject.

THE authorities of the Crystal Palace sent out on Saturday the allotments of space to the principal exhibitors of electric light at the forthcoming exhibition. If the various electric lighting companies and firms carry out their intentions, the palace will be lighted from the London, Brighton, and South Coast Railway Stations to the north end. The applications from intending exhibitors in other classes than that of lighting will be attended to this week, and it is hoped that the allotments will be issued on Saturday or Monday next.

THE Chinese authorities have recently recalled a large number of students from Hartford College, U.S., under somewhat peculiar circumstances. The youths had been specially selected in China to undergo a thorough course of instruction in various branches of knowledge in the United States. They were placed under the charge of Mr. Yung Wing, who at one time held a high diplomatic post at Washington, and whose knowledge of the language and country led to his selection for this purpose. A large building for their accommodation was purchased by the Chinese Government near Hartford, and every thing seemed to be going on well. Much surprise was therefore expressed when, long before the termination of their course of study, the young men were suddenly recalled, and by this time they have all reached China. It appears that a high official of the Government, on his passage through America to Europe, examined the institution where his young countrymen were being trained. He was alarmed to find they were being rapidly Americanised, and that some had gone so far as to part with their pigtails, and dress in foreign garments. He thought also that he noticed a growth of ideas in their minds which, however congenial to a republic, were out of the question in China; that the youths' minds would gradually be alienated from their native country, and that the impressions which they were imbibing might lead to trouble and disaffection in China. He accordingly wrote to Peking, recommending the recall of the mission. His views were immediately adopted; but it is hoped that the students will not lose much, as they are about to be sent to European countries, to which the same objections do not exist as to the United States. The incident shows very clearly that, however anxious the Chinese may be for the science and knowledge of the west, they want none of its political doctrines.

ON Tuesday a deputation, consisting among others of Lord Harberton, Sir Antonio Brady, the Hon. Rollo Russell, Capt. Galton, C.B., Col. Festing, R E., Prof. Chandler Roberts, F.R.S., Mr. Ernest Hart, Mr. George Shaw, and Mr. W. R. E. Coles, waited upon the Lord Mayor at the Mansion House, and asked him to open the exhibition and trials of smoke-preventing appliances now about to be held at South Kensington. The earnest effort, they said, of the Committee had been to encourage general improvement in the methods and appliances by which heat was obtained, and thus to secure the advantages of greater economy of fuel and lessened smoke. That effort had been so far successful that a very considerable number of economical and effective grates, stoves, and furnaces had been brought forward, and many improved methods of firing and other smoke-preventing means had been introduced. The Lord Mayor acceded to the request of the deputation, and the Committee promised to communicate with him as to the day of opening the exhibition, which will probably be about the end of the month.

THE English Royal Commission on Technical Education have, the *Times* correspondent states, been busy in Paris in visiting the higher, the secondary, and the primary schools. and particularly those in which manual and technical instruction is provided. It is their intention to inquire into the state of instruction in the districts in which cotton, woollen, and silk manufactures are carried on, and also in some of the chief pottery manufactories abroad, and to ascertain what resources are available for the same purpose in the corresponding manufacturing districts in England—an inquiry which they have already commenced by visits to Yorkshire and Staffordshire. During the winter they will continue to study the condition of technical instruction in the English manufacturing districts, and in the spring it is their intention to visit Germany, where the chairman, Mr. Samuelson, on a late visit to Berlin, has already set on foot some preliminary investigations.

THE banquet in honour of Prof. Virchow is to be held at Berlin on the 19th inst., in the Rathhaus, and promises to be highly brilliant and successful. The sum of 30,000 marks, originally proposed to be raised for the memorial, appears likely to be greatly exceeded. This memorial will consist of a marble bust of the Professor, and will be placed in the hall of the Pathological Institute on the above-mentioned day, in commemoration of his twenty-five years' labours as a teacher of medical science.

THE *Morning Post* states that, among other experiments now being conducted by a chemist at the Royal Short-horn Dairy at Dytchleys, Essex, the powers of carferal, already well known as a filtering medium in the removal of ammonia from sewage, are being investigated. It has been found that all ammonia is taken up by the carferal, as is indicated by testing the fluid after it has passed through it, and the resultant is a material valuable in breaking up and manuring heavy land.

THE Nürnberg Natural History Society recently made an excursion to Berg near Neumarkt (Upper Palatinate), and upon this occasion a large number of Teleosaurus bones (vertebræ and others) were found at the boundary between brown Jurassic and Lias. Besides these fine specimens of Belemnites, Ammonites. and Terebratulæ were found. The bones in question are of course completely petrified; the impressions of the scaly hide on the back are well preserved. All the objects found are now deposited in the Society's collection.

THE Pesth correspondent of the *Daily News*, telegraphing on the night of the 9th inst., states that Agram has again experienced a violent shock of earthquake. Shocks of earthquake, sufficiently severe to occasion considerable alarm, were felt at Château d'Oex, Canton Vaud, on Wednesday night and Thursday morning last week. The second of the shocks, which appear to have been altogether local, was accompanied by loud rumblings. There were three slight earthquake shocks in various parts of Switzerland last month, all local, and affecting only a very limited area. The first occurred at Monthey, in the Valais, on October 14; the second at Berne, on October 17; and the third at Zürich, on October 27. A violent earthquake was felt on October 27 at 10.30 p.m. in the northern part of the canton of Zürich. On the same day at 4.30 a.m. a slight shock was felt at Cilli and several other places in Styria.

THE death is announced of Dr. Eduard Simon Heine, Professor at Halle University, an eminent mathematician. He died at Halle on October 24 last.

WE regret to announce the death of Dr. Carl Arendts of Munich, a well-known geographer, and founder of the Geographical Society of that city. Dr. Arendts died at Possenhofen on October 11, aged sixty-seven years. He was the author of numerous standard works, and editor of the excellent *Deutsche Rundschau für Geographie und Statistik*, which has just commenced its fourth volume.

OUR readers are aware that Dr. Kobelt visited North Africa and Spain last spring, by the assistance of the Rüppell Institution of Frankfort, in order to investigate the molluscous fauna of the two countries, as well as to gather evidence bearing upon the question how far the land-connection between the two countries extended in bygone ages. He now reports that it may safely be assumed that the connection was not confined to the Straits of Gibraltar, but extended at least as far as the meridian of Oran and Cartagena. Dr. Kobelt will publish the detailed results of his investigations in the malacozoological journal, of which he is the editor.

THE Gotha Natural History Society will arrange an exhibition of natural history and geographical objects from November 20 to December 20. The Duke of Saxe-Coburg Gotha has lent the Society a suite of rooms in the Castle for this purpose.

A TUNNEL through the Col de Somport, near the Pic du Midi, in the Pyrenees, is the next large engineering work which will be undertaken in France. It will shorten the railway distance between Paris and Madrid by 100 kilomètres, the Spanish line passing by way of Ayerbe, Caldearenas, Jaca, and Confranc, leading on the French side into the Gave de Aspe valley and Oléron.

WE have before us the prospectus of a new entomological monthly journal, to be styled the *Wiener entomologische Zeitung*, of which the first part is to appear at the beginning of 1882, each part to consist of a sheet and a half of text, large 8vo. The editors are Ludwig Ganglbauer, Dr. Franz Löw, Prof. Josef Mik, Edmund Reitter, and Fritz Wachtl, all of Vienna, and it will be published by Alfred Hölder of that city. With so strong a staff it should prove a success. In some respects it is intended as a successor to the for many years defunct *Wiener entomologisches Monatsschrift*.

MR. LEO LESQUEREUX, we learn from the Harvard Library *Bulletin*, No. 3, has made a preliminary Report on the Plants of the Dakota Group collected by Mr. Sternberg for the Museum of Comparative Zoology (to be published in the *Museum Bulletin*). He says the collection is valuable in regard to the data it furnishes in confirmation of, or contradiction to, some of the general conclusions derived from the examination of the materials formerly described from this peculiar Cretaceous flora. For example, the disconnection of the flora of the Dakota group from that of the older zones—those of the Jurassic times—does not appear now so positive as formerly, or as it was indicated in the Cretaceous Flora Reports of Hayden's Survey. On the other side, the disconnection of the Cretaceous flora from that of the Lower Tertiary appears now still more evident, as the new species do not indicate any affinity with the plants of the Laramie group, which is positively Eocene by its types. Mr. Lesquereux is inclined to explain the distribution of the fossil plants of this group over small areas, as showing that the trees apparently grew around small hillocks or dry surfaces of land disseminated in wide lagoons. If derived from distant shores the leaves should be more or less mixed, while a comparison of the different localities shows that the fossil leaves were derived from trees grown in the places where they are now found fossil.

THE complete annihilation of Elm, according to the Geneva correspondent of the *Daily News*, appears to be now only a question of time and a little bad weather. At the request of the Government, Prof. Heim has just made another inspection of the Tschingel. He finds the work of disintegration proceeding much more rapidly than he expected. The entire summit of the Risikopp, the peak nearest Elm, is in movement, and its fall is not likely to be long delayed. It may miss the village, but the chance is very remote. The inhabitants remain meanwhile in their houses, which they have not to quit until the sentinels who are watching on the mountain warn them that danger is imminent.

IN Japan, according to a recent return, there are in all 159 hospitals where the patients are treated on the principles of western medicine. Thirty-five of these are private institutions in the sense that they receive no government aid, while twelve are naval or military hospitals. The remainder are scattered throughout the country; but they are said to be, in the remote districts, in a very crude condition. Vaccination, which is compulsory, is performed *gratis* everywhere. A law prohibiting the practice of physic or surgery by any except persons holding certificates of permission has recently been passed. A large school of medicine, with German professors, has been established for the past eight or ten years in the capital.

AT Nagy-Look (Hungary) the remains of a two-wheeled Roman car were lately discovered, with the skeletons of two horses attached to it. The objects are believed to date from the third century, and the place where they were found to have been the tomb of the owner. All the parts of the carriage are of most exquisite workmanship.

THE Russian Government intend to construct a canal between the Dnjepr and Düna Rivers, the Orschitsa, a tributary of the Dnjepr, to form a part of the canal. The distance by water between the Euxine and the Baltic would thus be shortened by 415 versts.

A ROUMANIAN mechanic, Traiano Feodoresen, recently submitted to the Chamber at Bucharest a project of a submarine vessel, and after examination of this by a committee the Government was authorised to meet the expense of construction. The vessel is to be capable of moving under water, at a depth of 30 metres, for twelve hours, without requiring renewal of air. Steam is the motor, and the speed is quicker than that of sailing vessels. The vessel is simply sunk by opening certain valves, but return to the surface requires more complex operations. An electric light will render objects distinguishable at 30 or 40 metres. For renewal of air it is not necessary that the vessel rise to the surface; an apparatus can be sent up, which, by actuating a pump, forces air into suitable receivers.

It is often supposed that the reality of alchemy, the transformation of the base into the noble metals, was generally accepted by orientals. But, according to Herr E. Wiedemann (*Ann. der Phys.* No. 10), some of the most noted *savants* rejected the idea. In his Prolegomenon, Ibn Khaldûn maintains that the transformation of metals is impossible, the philosopher's stone cannot exist, and the study of alchemy is ruinous. His own views, however, interest us less than his citation of Avicenna and his school as opponents of alchemy. While Abu Nasir al Farâbi, an older philosopher, held that all metals belong to the same species, and differed only in accidents, so that a transformation of these into each other was possible, Avicenna maintained that the metals differed in species, and that their specific differences, ordained by God, were therefore not alterable by chemical operations. A noted alchemist, Togair, contended, against this, that the task of alchemy was not to impart these differences to metals, but only to alter the latter so that they might be enabled to acquire them; the means to this being the elixir. A great predecessor of Avicenna, Al Kindi, also appears to have opposed alchemy.

The additions to the Zoological Society's Gardens during the past week include two Vulpine Phalangers (*Phalangista vulpina*), a Rufous Rat Kangaroo (*Hypsiprymnus rufescens*) from Australia, presented by Mr. F. J. Horniman, F.Z.S.; a Ring-necked Parrakeet (*Palæornis torquata*) from India, presented by the Countess Dowager of Lonsdale; two Long-eared Owls (*Asio otus*), British, presented by the Rev. J. A. Wix; two Grey Wagtails (*Motacilla sulphurea*), British, presented by Mr. Swaysland; a Dufresne's Amazon (*Chrysotis dufresniana*) from South-East Brazil, a Yellow-cheeked Amazon (*Chrysotis autumnalis*) from Honduras, an Orange-winged Amazon (*Chrysotis amazonica*) from South America, deposited; a Pluto Monkey (*Cercopithecus pluto*), a Sykes's Monkey (*Cercopithecus albogularis*) from West Africa, a Darwin's Rhea (*Rhea darwini*) from Patagonia, a Picazuro Pigeon (*Columba picazuro*) from South America, two Spotted Zenaida Doves (*Zenaida maculata*) from La Plata, two Dominican Gulls (*Larus dominicanus*) from Antarctic America, purchased.

EXPERIMENTS ON COLOUR[1]

In a former paper with the above title (NATURE, vol. iii. p. 234) I described some combinations of absorbing media capable of transmitting the red and green, while stopping the other rays of the spectrum. In this way I obtained a *purely compound* yellow, made up of red and green, and free from homogeneous yellow light. In devising such combinations we have in the first place to seek an absorbing agent capable of removing the yellow of the spectrum, while allowing the red and green to pass. For this purpose I used an alkaline infusion of litmus, or solution of chloride of chromium, placed in a trough with parallel glass sides. In order to stop the blue rays we may avail ourselves of chromate of potassium. If a second trough be not objected to, it is best to use the bichromate, as exercising the most powerful absorption upon the upper end of the spectrum; but the bichromate cannot be mixed with litmus without destroying the desired action of the latter upon yellow. In this case we must content ourselves with the neutral chromate.

During the last year and a half I have resumed these experiments with the view, if possible, of finding solid media capable of the same effects, and so of dispensing with the somewhat troublesome troughs necessary for fluids. With this object we may employ films of gelatine or of collodion, spread upon glass and impregnated with various dyes, gelatine being chosen when the dye is soluble in water, and collodion when the dye is soluble in alcohol. Thus in the case of litmus a slightly warmed plate is coated with a hot and carefully filtered solution of gelatine, allowed to remain in a perfectly horizontal position until the gelatine is set, and then put aside to dry, by preference in a current of warm air. The films thus obtained are usually somewhat rough upon the surface, so that I have preferred to use two pieces cemented together, coated sides inwards, with Canada balsam. In conjunction with the litmus we may employ a silver-stained orange glass, and so isolate the red and green rays. For the orange glass Mr. C. Horner has substituted a film of collodion stained with aurine. Samples possibly vary; but that which I have used, though extremely opaque to the blue green rays, and therefore so far very suitable for the purpose, allows a considerable quantity of the higher blue to pass. By spreading aurine upon a pale yellow glass, I obtained a very perfect absorption of the blue-green and higher rays. Plates prepared as above described answer the purpose very well; but I have found that in some cases the litmus in contact with the balsam becomes slowly reddened, the action creeping inwards from the edge. A dye, capable of replacing litmus, and free from this defect, is "soluble aniline blue," whose absorption, as I found rather unexpectedly, begins in the yellow and orange. Bichromate of potash and aniline blue may be mixed in the same solution, and there is no difficulty in so adjusting the proportions as to secure a good compound yellow. To obtain solid films gelatine must be used, as in the case of litmus, for the dye is not soluble in collodion. With aniline there is no difficulty from the Canada balsam, and two plates cemented together answer perfectly.

For systematic observations on compound colours nothing probably can be better than Maxwell's colour box in its original form; but it seemed to me that for the examination of certain special questions a more portable arrangement would be convenient. In an instrument of this class a full degree of brightness requires that the width of the eye-slit, placed where the spectrum is formed, should not contract the aperture of the eye, *i.e.* should not be less than about one-fifth of an inch; and although the maximum of brightness is not necessary, considerations of this kind largely influence the design. If we regard the width of the eye-slit as given, a certain length of spectrum is necessary in order to attain the desired standard in respect of purity of colour; so that what we have to aim at is a sufficient linear extension of the spectrum. A suitable compromise can then be made between the claims of brightness and purity.

The necessary length of spectrum can be obtained by increasing either the angular dispersion of the prisms or the focal length of the lens by which the image is formed. If portability be no object, the latter is the preferable method, and the focal length may well be increased up to five or six feet; in this way we may obtain a field of view of given purity of colour and of maximum brightness, at the expense only of its angular extent. If, however, we desire an instrument which can be moved from one place to another without losing its adjustment, the focal length of the lenses must be kept down, and then a large prismatic dispersion is the only alternative.

Increased dispersion can of course be obtained by multiplication of prisms; but for the purpose in view, high resolving power is not wanted, and our object may be attained with a comparatively small total thickness of glass, either by the use of higher angles than usual, or by giving the light a more nearly grazing emergence. The latter was the course adopted in designing the first instrument of which I have to speak. A pair of prisms of 60°, cut from an ordinary single $1\frac{1}{4} \times 1\frac{1}{4}$-inch prism along a plane bisecting at right angles its refracting edge, were arranged in the corner of a shallow box, so as to form what Thollon calls a *couple*. Considered as a simple, rigidly connected refractor, the pair of prisms are placed so as to give minimum deviation, but the incident and emergent light makes smaller angles with the final surface, than if each prism were adjusted separately for minimum deviation. The collimating and focussing lenses are common spectacle glasses of about 8" focus. The box is $12'' \times 12'' \times 3''$. Light entering at a slit on one of the sides of the box would be turned by the prisms through an angle rather greater than a right angle, and throw a pure spectrum upon another side of the box. This side is cut away, and provided with movable screens of cardboard, so that any part may be open or closed as desired. When the eye is applied to the first slit, the prisms are seen uniformly illuminated with colours whose composition depends upon the situation and width of the slits between the cardboard screens through which light is allowed to enter. In this way we may obtain a uniform field of view lighted with any combination of spectral colours. My object, however, was to obtain an instrument for making comparisons between the simple and compound yellow, and for this purpose an addition was necessary. This consisted

[1] Read before Section A of the British Association, September 2, 1881, by Lord Rayleigh, F.R.S.

of a very acute-angled prism held close to the dispersing prisms in such a position that its refracting edge was horizontal, dividing the field of view into two equal parts. The action of this prism is most easily understood by again supposing the light to enter at the eye-slit. Half of the light proceeds as before, forming ultimately a pure spectrum upon the side of the box. The upper half of the beam, however, is deflected by the acute-angled prism, and the corresponding spectrum is thrown upwards, so as to lie somewhat higher upon the side of the box. This part is also cut away, and provided with movable screens. By the principle of reversibility the consequence is that an eye placed at the first slit sees *two* uniform patches of colour, the lower formed as before by light from the lower set of slits, the upper, covering the acute-angled prism, by light from the upper set of slits. These colours are in close juxtaposition, and may be compared with ease and accuracy.

The great difficulty in this class of instruments is to devise any efficient and reasonably simple method of controlling the position and widths of the slits. In the present case I contented myself with strips of blackened cardboard cemented to the side of the box with sealing-wax, or soft wax, according to the degree of permanence of adjustment aimed at. One part of the field was illuminated with homogeneous yellow (about the line D) from a single slit. The other half was lighted with a mixture of full red and full green, and the observation consisted in adjusting the widths of the slits through which the red and green were admitted, until the mixture was a match with the simple yellow.

The first trials of this instrument in the spring of last year revealed an interesting peculiarity of colour vision, quite distinct from colour blindness. The red and green mixture which to my eyes and to those of most people matches perfectly the homogeneous yellow of the line D, appeared to my three brothers-in-law hopelessly too red, "almost as red as red sealing-wax." In order to suit their eyes the proportion of red had to be greatly diminished, until to normal sight the colour was a fair green with scarcely any approach to yellow at all. So far as could be made out at the time, the three abnormal observers agreed well among themselves, a fact which subsequent measurements have confirmed. It appeared afterwards that a fourth brother was normal as well as the three sisters.

These peculiarities were quite unexpected. After the fact had been proved, I remembered a dispute some years before as to the colour of a dichromatic liquid, which appeared to me green, while one of my brothers-in-law maintained that it was red; but the observation was not followed up, as it ought to have been, each of us, I suppose, regarding the other as inaccurate. After the establishment of the difference I determined to carry out a plan, which I had tried with success some years before (October 1877), for a colour-mixing arrangement depending on double refraction, by which I hoped to obtain an easily adjustable instrument suitable for testing the vision of a number of persons.

In my original experiments I used a 60° doubly refracting prism of quartz, which threw two spectra of the linear source upon the screen containing the eye slit. These oppositely polarised spectra partially overlapped, and by suitable placing of the prism could be made to furnish red and green light to the eye. By the rotation of a small Nicol held immediately behind the eye slit, the red or green could be isolated or mixed in any desired proportion. One advantage of this arrangement is that the two component lights come from the same slit, so that we are less dependent upon the uniformity of the light behind; but it is perhaps a greater merit that the adjustment of proportions is effected by simple rotation at the eye slit, allowing the observer to try the effect of small changes with ease and rapidity.

In the new instrument, which was completed during the autumn of last year, separate prisms were used to effect the dispersion and double refraction. For the sake of compactness, a direct vision prism by Browning, containing two flints and three crowns, was chosen, in conjunction with a small achromatic double image prism. At one end of a long narrow box, 24″ × 2″ × 2″, the light is admitted through a slit whose position and width can be adjusted by sliding its jaws along a divided scale. After travelling about $9\frac{1}{4}''$ it falls upon the double image prism mounted upon a small table so as to allow of rotation, and then after two more inches upon a collimating lens, by which the two beams are rendered parallel. Next comes the dispersing prism, and then the focussing lens, throwing pure spectra upon the other end of the box, which carries the eye slit. The distance between the two lenses is $3\frac{1}{2}''$, and the entire length of the box is about 24″. The eye slit is a fixture, and immediately behind it is the rotating Nicol, whose position is read by a pointer on a divided circle.

The parts of the spectrum from which the component lights are taken can be chosen over a sufficient range by use of the two adjustments already mentioned. By rotation of the table on which the double image prism is mounted, the separating power is altered, and one spectrum made to slide over the other, while by moving the entrance slit the spectra are shifted together without relative displacement.

It yet remains to describe the parts by which the comparison colour is exhibited. Between the double image prism and the collimating lens a small vertical reflector is mounted on a turn-table at an angle of about 45°. Its dimensions are such that it covers the lower half of the field of view only, leaving the upper half undisturbed, and its function is to reflect light coming from a lateral slit through the dispersing prism so as to throw a third spectrum upon the eye. The lateral slit is carried in a small draw tube projecting about 2″ from the side of the box, and the light proceeding from it is rendered nearly parallel before reflection by a lens of short focus. No adjustment is provided for the position or width of the lateral slit; all that is necessary in this respect being attainable by rotating the mirror and by varying the brightness of the light behind. As sources of light I have found Argand gas flames, surrounded by opal globes, to be suitable. The gas tap supplying the lateral flame is within reach of the observer, who has thus the means of adjusting the match both with respect to colour and with respect to brightness, without losing sight of the subjects of comparison. The zero of the divided circle corresponds approximately to the complete exclusion of green, but readings were always taken on both sides of it so as to make the results independent of this adjustment. The circle is divided into 100 parts, green being excluded at 0 and 50, and red at 25 and 75. Tenths of a division could be estimated pretty correctly, an accuracy of reading fully sufficient for the purpose, as the observations of even practised observers would vary two or three-tenths.

It is evident that the numbers obtained are dependent upon the quality of the light by which the principal slit is illuminated. In order to avoid errors in the comparison of different persons' vision arising from this source, it is advisable always to take simultaneous observations from some practised individual whose vision may be treated as a standard; but no evidence appeared of any variation in the quality of the gaslight. The special application of such instruments to the comparison of the qualities of various kinds of mixed light was alluded to at the end of my paper "On the Light from the Sky," &c. (*Phil. Mag.*, April, 1871).

I have obtained matches between simple and compound yellow from twenty-three male observers, principally students in the laboratory. Of these sixteen agree with myself within the limits of the errors of observation. The remaining seven include my three brothers-in-law, and two others, Mr. J. J. Thomson and Mr. Threlfall, whose vision in this respect agrees very nearly with theirs. The vision of the other two observers differs from mine in the opposite direction. In one case the difference, though apparently real, is small, but in the other (Mr. Hart), though there was some difficulty in getting a good observation, the difference is most decided. Among seven female observers whom I have tried, there is not one whose vision differs sensibly from my own.

Although the number examined is insufficient for statistical purposes, it is evident that the peculiarity is by no means rare, at least among men. As far as my experience has gone, it would seem too as if normal vision were not of the nature of an average, from which small deviations are more probable than larger ones; but this requires confirmation. In order to give a more precise idea of the amount of the difference in question, I have calculated from the laws of double refraction the relative quantities of red and green light required by Mr. F. M. Balfour and myself to match the same yellow light. If we call R and G the maximum brightnesses of the red and green light (as they would reach the eye if the Nicol were removed), and r, g the actual brightnesses (as modified by the analyser) necessary for the match, then for Mr. Balfour—

$$r/g = 1\cdot50\ (R/G),$$

while for myself—

$$r/g = 3\cdot13\ (R/G).$$

In other words, Mr. Balfour requires only half as much red as myself, in order to turn a given amount of green into yellow.

The corresponding numbers for the other four observers of this class would be substantially the same. On the other hand, Mr. Hart requires much *more* red than I do in order to convert a given green into yellow—in the ratio of about 2·6 : 1.

Except in the case of Mr. Hart, the colour vision of these observers is defective only in the sense that it differs from that of the majority. Their appreciation of small colour differences is as distinct as usual. In order to test this Mr. G. W. Balfour made a complete series of colour matches with revolving disks in the manner described by Maxwell and in my former paper. Six matches, of which only two are really independent, were observed, the consistency of the set being a measure of the accuracy of observation. The average error proved to be only double of that which I have found in my own observations, and rather less than that usually met with in the case of observers whose vision is normal.

In connection with what has been described above with respect to trichromic vision, it is interesting to notice that corresponding and perhaps larger differences are to be found in the vision of the so-called colour-blind. The double-refraction apparatus may conveniently be used in this investigation. With the pointer adjusted to 0 or 25, we have in the upper half of the field pure red or pure green respectively, and in the lower half pure yellow as usual. By suitable adjustment of the gas taps two observers of this class, Mr. T—— and Mr. B——, are able to obtain perfect matches both between red and yellow, and between green and yellow, but the proportions necessary are very different for the two observers. In Mr. T——'s red and yellow match, the red is to normal vision dazzlingly bright, and the yellow almost too dark to be recognised; while the green and yellow match, however extravagant as to hue, appears reasonable in respect of brightness. On the other hand, to Mr. B——'s eyes, the red of the spectrum does not look nearly so dark, and the equivalent red and yellow appear to the normal eye to be much more nearly upon a level. Although these great differences exist, there is no doubt that the vision of both observers is strictly dichromic, and that, apart from brightness, all the rays of the spectrum, from red to green, have the same effect upon their eyes.

If we wish to go beyond the fact that this vision is dichromic, and inquire whether the case is one of red blindness or of green blindness, we must be careful to consider whether the question itself has a definite meaning. If trichromic vision were always the same, and if a particular case of colour-blind vision differed from it merely by the absence of the red sensation, that vision would intelligibly be characterised as red-blind. There is reason to believe that such cases exist. In all probability the suppression of my own red sensation would lead me to make matches very nearly the same as Mr. T——'s; and in this sense he may fairly be called red-blind. But under the same circumstances my matches would be altogether rejected by Mr. B—— ; and the question may be asked, whether his case, being certainly not one of simple red-blindness, can be brought under the head of green-blindness. To this the sufficient answer is that if I became green-blind my matches would differ from those of Mr. B—— far more than if I was red-blind. The test of green-blindness would be the possibility of matches between colours which to normal eyes appear green and purple, or green and grey. Although a good deal has been said lately on this subject, I am not aware of a case in which accurate matches of this kind have been obtained from observers whose colour-vision is in other respects acute. If such cases exist, inquiry should be instituted, in order to see how far the matches would correspond to green-blindness of an otherwise normal eye.

We see, then, that there is dichromic vision which cannot accurately be described as affected with red-blindness, and still less as affected with green-blindness. The difference from normal vision, being not simply one of defect, cannot be defined by any single phrase. To obtain a complete knowledge of it quantitative observations over the whole spectrum, such as those carried out by Maxwell, are necessary. It is fortunate that these observations are easier to arrange for dichromic than for trichromic vision.

That I might be able to form an opinion upon the general acuteness of his colour vision, Mr. T—— was good enough to observe a series of five colour matches between red, white, blue, green, and yellow, one being left out each time. The results are given in the accompanying table; those marked "calculated" being a consistent set derived by elimination from the two marked A and B. The good general agreement of the two sets of numbers is a proof that within its restricted range Mr. T——'s sense of colour is acute. The first observation in which a mixture of red and white is matched by a mixture of green and blue is the most characteristic.

	Red.	White.	Blue.	Green.	Yellow.	Dec. 2, 1880.
(1)	76·2	23·8	−23·3	−76·7	0	Observed
	77·4	22·6	−21	−79	0	Calculated
(2)	56·6	43·4	−52·3	0	−47·7	Observed
	56·2	43·8	−52·5	0	−47·5	Calculated
(3)	68·2	5·5	0	−100	26·3	Observed
	69·7	6·5	0	−100	23·8	Calculated
(4)	60·3	0	8	−100	31·7	Observed
	61·2	0	7·8	−100	31	Calculated
(5)	0	32·5	−43·5	67·5	−56·5	Observed
	0	32·3	−44·1	67·7	−55·9	Calculated
A	522	424	−511	35	−470	—
B	641	405	−470	−199	−377	—

In conclusion I will describe an apparatus by which it is possible to observe these colour-matches without rotating the disks. At the time of my first experiments, about ten years since, I was struck with the advantage which might ensue if it were possible to have the mixed colours in view during the time of actual adjustment, and I thought of a plan by which this object might be attained. The idea, which I carried out soon afterwards, was to spin an *image* of the disks instead of the disks themselves. An inverting prism was mounted in a tube which could be made to rotate. The axis of rotation is adjusted so as to point accurately to the centres of the disks mounted as usual. An eye applied to the prism sees the disks undisplaced as a whole, but inverted by reflection. As the tube rotates, the image of the disks rotates also, and with double angular velocity. When the speed is sufficient, the colours lying on any circle concentric with the disks are blended exactly as if the disks themselves revolved.

This apparatus is quite successful; but its real advantages of working at a smaller velocity, and of allowing adjustment while the rotation continues, are counterbalanced in practice by the inconvenience of having to look through a tube, and the uncertainty introduced by the possible disturbance of the match due to unequal illumination of the area occupied by the disks.

MAGNETIC DISTURBANCES, AURORAS, AND EARTH CURRENTS [1]

THE object of establishing a magnetic observatory is to determine at any instant the direction and magnitude of the earth's magnetic force. The direction of the magnetic force of the earth is the direction in which a small magnetic needle would point when it is freely suspended, so as to turn about an axis passing through its centre of gravity. But it is not easy to suspend a magnetic needle so as to turn freely and yet to be sure that the axis about which it turns passes accurately through the centre of gravity of the needle, and if it does not so pass, then on suspending the needle we have not only the magnetic force but also the gravitating force of the earth acting upon it to turn it about its axis, and the position which it takes up shows us the direction of these combined forces upon the magnetic needle.

This direction depends upon the mass of the needle, for to that its weight is due; it depends upon the form of the needle and the position of its centre of gravity with regard to the axis on which it is hung; it depends also on the magnetic properties of the substance, so that it is not easy to determine even the direction of the magnetic force by a plan which theoretically is so very simple. Instead of attempting to make the required determinations by such a method it is necessary that a steadier mode of suspension should be adopted, and that may be done as soon as it is discovered in what vertical plane the force of gravity,

[1] Lecture delivered at the Royal Institution on Friday evening, June 3, 1881, by Prof. W. Grylls Adams, F.R.S.

combined with the earth's magnetic force, will cause such a needle to rest. This is usually done by loading a steel needle at one end and then magnetising it with its poles so arranged that the extra weight of the heavier end shall balance the downward pull of the magnetic force on the other end. In this case the needle when magnetised will remain at rest in a horizontal direction, when suspended on a point on which it can turn freely in a horizontal plane.

A magnetic needle suspended in this way has been called a declination needle. Such a needle is employed in the mariner's compass, in our galvanometers for measuring currents of electricity, and in magnetic observatories for determining the declination or what is sometimes called the variation of the magnetic needle. This needle determines the position of the vertical plane in which lies the direction of the earth's magnetic force; this is called the plane of the magnetic meridian. The plane of the *magnetic* meridian is usually different from the vertical plane through the north and south poles, which is called the geographical meridian, and the angle between these two planes is the declination or variation of the magnetic needle.

If such a magnetic needle as I have just described be supported on horizontal knife edges instead of being supported on a point, the needle when magnetised may remain at rest balanced in a horizontal direction, one end being pulled downwards by the earth's vertical magnetic force, and the other by the force of gravity. Any change in the intensity of the vertical magnetic force of the earth will be shown by an up or down motion of the marked end of the needle. Such an instrument, called a balance magnetometer, is specially adapted for showing any changes in the vertical magnetic force of the earth, and the changes or disturbances of the earth's *vertical* magnetic force are determined by means of such a balance magnetometer. We have then our declination or variation needle to determine the vertical plane, called the magnetic meridian, and we have our balance magnetometer to determine any changes which may take place in the vertical magnetic force of the earth.

By the declination needle we can not only determine the plane of the magnetic needle, but by making the needle oscillate to and fro horizontally and counting the number of oscillations in a given time we can determine the horizontal pull upon the poles of the needle, *i.e.* the intensity of the earth's horizontal magnetic force upon the needle, just as by the swing of a simple pendulum in a vertical plane under the action of the force of gravity we can determine the pull of the force of gravity upon the bob of the pendulum. By a similar method and by a properly suspended needle either the vertical force or the total magnetic force of the earth may be determined.

In order then to determine the direction of the earth's magnetic force we may make use of a declination needle to give us the vertical plane, and place the dipping needle in such a position that it will oscillate in that plane; when it comes to rest it will point in the direction of the total magnetic force, *i.e.* in the direction through the room of Faraday's lines of magnetic force.

In order to determine the magnitude of that force the horizontal force may be found by finding the number of oscillations of the declination needle in the way that I have already explained, and these three determinations will give us the direction and magnitude of the earth's total magnetic force.

Another method of making the required determinations is to take a coil of copper wire, which is wound on a circular frame in such a way as to be capable of spinning on a diameter of the circular frame.

Faraday showed that on turning such a coil in a mag etic field a current of electricity is induced in the coil, and the strength of this current is proportional to the number of lines of force cut by the coil. We may describe such an arrangement as a magneto-electric machine, in which the magnet employed is the earth itself.

By means of this instrument we may determine either the horizontal or the vertical magnetic force f the earth. By placing the axis vertical and spinning the coil at a given rate we may determine the horizontal force, and by placing the axis horizontal in the magnetic meridian and spinning the coil at the same rate we may determine the vertical force, the currents produced in the two cases being in the same ratio as the numbers of the lines of force cut in the two positions.

The greater the angle at which the axis of rotation is inclined to the direction of the lines of force the greater will be the number of them included in the revolving circle, and the greater the induced current produced in the coil.

Thus placing the axis in different positions we get currents of different strengths, and may readily see that we get the greatest current when the axis is at right-angles to the direction of the lines of force, *i.e.* to the line of the dip

We may further make use of such a coil to find the direction of the lines of force, for if we place the axis parallel to the lines of force, the currents in opposite halves of the coil will balance one another, because each line of force is cut twice by the coil, and so no current is produced in the external circuit through the galvanometer.

If then we place the coil so as to get no current when we rotate it, then the direction of the axis of the coil is the direction of the dipping needle, *i.e.* of the magnetic lines of force.

We will suppose now that for some point of time, say June 1st at 12 o'clock midday, the three magnetic elements, *i.e.* the declination, the horizontal force, and the vertical force, have been determined, we have now to consider the changes or disturbances produced in these magnetic elements, and the connection of these changes with other phenomena, and especially the connection between auroras, earth currents, and the larger and more irregular magnetic disturbances.

I have already drawn attention to the declination needle and the balance magnetometer for measuring the changes of declination and of the vertical force.

For measurement of the changes in the horizontal force a special instrument is employed, called a bifilar magnetometer, in which a magnet is suspended by two threads, which are so placed that by their torsion acting against the magnetic force of the earth, the magnet is kept at rest in a horizontal position in a direction at right angles to the magnetic meridian.

This completes the list of instruments for our magnetic observatory.

Any change or disturbance of the horizontal force pulls this magnet round more or less in the horizontal plane, and its change of position is observed as in the other instruments. The results I have to bring before you this evening have been derived from the photographic registrations of similar instruments in different parts of the world, so that the motion of the needle has recorded its own tale on the prepared paper which is wrapped on a cylinder driven by clockwork, and so placed as to receive the spot of light reflected by the moving needle.

First, there are regular daily and yearly changes, showing that the sun produces regular changes in the three magnetic elements which depend on the time of the day and the season of the year, so that the change of position and apparent motion of the sun with respect to the place of observation produce regular magnetic changes. These regular daily changes are accompanied by and have very generally been supposed to be due to electric currents or electric waves traversing the earth's crust, and a discussion by Dr. Lloyd of the observations made by Mr. Barlow in 1847 of currents on telegraph wires showed a very close relationship between the two-hourly changes of the declination needle and the changes of intensity and direction of earth currents on telegraph lines.

Both Dr. Lamont and Dr. Lloyd conclude from their comparisons of earth currents and magnetic changes that the changes of the declination needle cannot be due to the direct action of the electric current traversing the earth's crust, but that these currents or waves, extending to a considerable depth, alter by induction the magnetism of the earth itself, and this change of magnetism causes the observed changes in the declination needle. Thus the magnetic changes are the indirect effects of (not the earth current in its immediate neighbourhood, but of) a change in the magnetism of the earth itself, which may be due to an electric wave extending over a considerable area of the earth's surface.

The point towards which the total earth current is directed follows the sun and seems to lag two or three hours behind, but not the same distance behind at different places.

These earth currents have been ascribed to different causes: thus Dr. Lamont regards them as the results of electric force emanating from the sun; De Saussure regards them as developed by evaporation, the vapour being positively charged, and the water being negative; Dr. Lloyd regards them as effects of solar heat; whilst M. de la Rive ascribes them to chemical actions going on in the interior of the solid crust of the earth, the electricity being transported into the atmosphere by evaporation.

Mr. Ellis of the Greenwich Observatory has shown the intimate relation between solar action and the regular diurnal

magnetic changes of declination and horizontal force at Greenwich Observatory during thirty-five years from 1841 to 1876 by a comparison of the observations of those elements. The results of his observations are shown on a large diagram which has been enlarged from his curves, and they show what a close relationship exists between solar storms and terrestial magnetic changes. There are not only daily and yearly periods of the variations of the different magnetic elements, but there also seems to be in the horizontal intensity a period of twenty-five or twenty-six days, which is the time of rotation of the sun on his axis. Other recent investigations have shown that these regular magnetic changes depend not only on the sun, but that they are also in part due to the action of the moon, and these portions depend upon the length of the lunar day and on the position of the moon with regard to the earth. Just as there are regular earth currents whose direction depends upon the sun, which we may call the solar earth currents, so there are lunar earth currents which go through their changes under the action of the moon, and it has been shown that the effects are produced not immediately under the moon, but there is a lagging behind in the case of the lunar earth currents, just as in the case of the solar earth currents. In the case of the lunar earth currents we cannot attribute the production of the electricity either to heat or to thermo-electric currents from one part to another of the earth's crust, and we must therefore look for some other source. May we not find it in the fact that the moon causes tides in the solid crust of the earth, just as she causes tides in the oceans? The earth's crust is made up of elastic materials and materials capable of yielding and altering their form to a considerable amount with the change in the direction of the pull of the moon upon them. This crust also contains magnetic substances in abundance which alter their form under the moon's attraction, and so from the changes of position of masses of magnetic matter changes are produced in the magnetism of the earth which must give rise to induced currents of electricity or earth currents. Let us imagine a conductor of electricity outside the earth, stretching from the North Pole to the equator and fixed in space, with the earth, a magnetic body, revolving beneath it from west to east; then it follows, from Faraday's laws of induced currents, that the revolution of the earth on its axis would cause a current in the fixed conductor in a direction from the pole to the equator.

If the conductor moved over the surface of the earth from west to east, and the earth did not revolve, or revolved at a slower rate, then the current in the conductor would be from the equator to the pole. The current depends upon the relative motion of the earth and the wire. If then we have an insulated wire running north and south, the tides in the earth's crust, of which I have spoken, will be equivalent to a lagging behind of magnetic matter, and so we may expect in that wire a current of electricity whose general direction would be from the equator to the pole. The position of the wire with reference to the magnetic pole of the earth would modify the direction of these earth currents, and it is quite conceivable that the position of England with regard to the magnetic pole might cause these regular earth currents to be greatest in the south-west and north-east direction. The lagging of the lunar earth currents behind the position of the moon would also be accounted for by the lagging of the tides behind the moon. If this is a true cause for some portion at least of the lunar earth currents, then the same reasoning applied to the sun may in a smaller degree apply to the case of the regular solar diurnal earth currents, and may help to account for the lagging behind of the effects due to the sun, so that the fact that the greatest solar effect happens about 2.30 p.m. may not be entirely due to the fact that that is the hottest part of the day, but may also in part depend upon the tides.

We have now to consider those more sudden changes of the suspended magnets, which are distinguished by the name magnetic disturbances. In 1874 Dr. Lloyd said of them:—"The duration and the magnitude of these oscillations are as yet outside the domain of law, and probably depend upon so many operating causes that, like the gusts and lulls of the wind in an atmospheric storm, they will long baffle all attempts to refer them to their actuating forces, or even to reduce them to order."

Certain facts relating to these disturbances have long been known. From the series of observations started by Gauss in 1834, and made every five minutes at the same times at a variety of places, at first in Europe and afterwards in various parts of the world, the disturbing power was found to increase in northern latitudes; also it was made out that the appearance of a disturbance in several places occurred at the same time, but there were great differences in the results at different places.

In Europe the agreement was very good, and also in America; but the agreement between Europe and America was not so satisfactory.

The force seemed to originate in a certain point in the interior of the earth, and the direction of the disturbing force seemed to be constant: yet sometimes there were great differences in the deviations at places not far apart, and from the result of his observations Weber was led to believe that there was a centre of disturbances which was somewhere in the neighbourhood of St. Petersburg.

However sudden and unconnected single disturbances may seem to be, they still follow certain laws in their occurrence; Sabine found that they had daily and yearly variations from their mean values, and that they have an eleven-year period, which agreed with the eleven-year period of the appearance of spots upon the sun.

Disturbances are more frequent in summer than in winter, and this applies to each hemisphere; and it has been confirmed by various observers that they are also subject to the influence of the moon. Lamont says of these disturbances, "Their cause is a force which is subject to certain laws but which does not act constantly; the mean direction and frequency have yet to be discovered."

Observations have shown that the magnetic disturbances and electric currents on the earth are so nearly related to one another that people naturally look upon the electric currents, either in the crust of the earth or in the atmosphere outside it, as the cause of the magnetic disturbances. These currents in the earth have usually been attributed to changes of temperature, because they also are found to be in some way governed by the sun.

Now let us come to more recent observations of magnetic disturbances with the improved methods of recording observations by photography which are now available. For some years past photographic records have been taken of the magnetic elements, but the curves have been laid aside, and very little use has been made of them; so much so that some three or four years ago a circular letter from Mr. Ellery, Director of the Melbourne Observatory, was sent round to those scientific men who were supposed to be interested in the matter to know whether it was advisable to continue the photographic records of magnetic changes at Melbourne, which is the most southern station, and the only station in the southern hemisphere except Mauritius, where such observations are taken. Mr. Ellery did not for one moment suppose that they were of no value, but as no use was made of them he wished to know whether the money expended might not be better applied to another purpose. This matter has been taken up by the Kew Committee, of which Dr. De La Rue is the chairman, and a recommendation was made that the directors of all observatories which possess instruments of the Kew pattern should be invited to send to Kew their photographic records, or careful tracings of them, for a given period, so that a comparison might be made of the results.

The period chosen was the month of March, 1879, and records for the whole month have been sent from Lisbon, Coimbra, Stonyhurst, Vienna, St. Petersburg, and Bombay, in the northern hemisphere, and from Melbourne and the Mauritius in the southern hemisphere.

A preliminary account of a comparison of the declination curves from the European stations was brought before the British Association last year at Swansea, and this evening I have to bring before you some further points which come out of these comparisons. Let us take the disturbances on March 15-16, 1879, which will illustrate some of the points which I wish to bring out prominently.

Not only do magnetic changes occur at the same time at different stations, but there is a great similarity between them.

It must be remembered that at northern stations the horizontal force is smaller in proportion to the whole force than it is at stations nearer to the equator, so that the same disturbance will produce less effect on the horizontal force or on the declination needle in latitudes near the equator.

Also the needles at different stations are by no means in the same state of sensibility, and even at the same station they change with time, so that they are not always equally sensitive, and when they lose their magnetism they have to be re-magnetised.

We see that soon after 10 a.m. G.T. on March 15, 1879, there is a disturbance wave showing first a diminution and then an

increase in the horizontal force at St. Petersburg, Vienna, Kew, and Lisbon. At Melbourne in Australia there is a similar disturbance at the same time both in the declination and in the horizontal force.

Again, between 2 and 3 and between 4 and 5 p.m. there are very small disturbances showing themselves at the same absolute time in the horizontal force and declination curves. About 5.20 p.m. there is a well marked increase in the horizontal force and eastward deflection of the declination needles. About 9.30 p.m. G.T. a storm begins which lasts for about an hour. It is felt in the northern and in the southern hemispheres, near to and on both sides of the equator. At all European stations the horizontal force is increased during the first part of the storm, and then diminished.

At Lisbon the vertical force is first increased and then diminished, and at St. Petersburg and Stonyhurst there is a diminution in the vertical force at the same time as at Lisbon. If we regard the declination needles, we find that at St. Petersburg, Zi-ka-Wei, and Melbourne, and at Bombay, the declination westward is first increased and then diminished, whereas at Kew and Lisbon the motions are in the opposite direction.

The declination at Vienna seems to be intermediate between Kew and St. Petersburg, but the curve is incomplete.

At Bombay and the Mauritius, near to but on opposite sides of the equator, the declination needles are deflected opposite ways. The local time at these places was from 1 to 2 o'clock at night.

Now in what way can we account for such magnetic disturbances as this? If we assume that by magnetic induction from some cause or other the earth's magnetism is altered, then the position of the magnet which would produce the disturbance must be such that its pole which attracts the marked end of our needle must lie at the beginning of the disturbance to the east of Kew and Lisbon, to the north of Vienna, and to the north-west of St. Petersburg; the Lisbon vertical force curve also shows it to be below the surface of the earth. Hence an inductive action equivalent to a change of position of the north magnetic pole towards the geographical pole would account for these changes. The strengthening and weakening of a magnet with its north pole to the north on the meridian of Vienna might possibly account for the magnetic changes observed between 9.30 and 10.30 at night, Greenwich time, on March 15, 1879.

If we attempt to explain this disturbance by currents of electricity or discharges of statical electricity in the air above the needles, then we must imagine that at first there is a strong current from the south-west over St. Petersburg, from the west over Vienna, and from the north-west over Kew and Lisbon, the vertical force needle at Lisbon showing that the current from the north-west lies somewhat to the east of Lisbon, that at the Mauritius this current is from the north, and at Bombay from the south.

Hence we must imagine that a current of electricity passes down from north-west to the south-east, going on towards the east over Vienna, and towards the north-east over St. Petersburg. This must be kept up very much along the same line throughout the first part of the disturbance, and then the current or currents must be altered in strength in the same manner at all stations.

We will next consider what would hardly be called a magnetic storm, but a few very small deviations of the magnetic needle, lasting from about 5.30 to 7.30 p.m. on March 26, 1879. Only the comparison of the originals will give the closeness of the similarity of the curves, and the curves for Vienna and Kew are absolutely coincident.

When the declination needle is deflected to the west, the horizontal force needle is deflected with its marked end towards the south, so that in this disturbance the two needles are drawn towards the south-west at the same time with greater or less power, and twelve similar bends are clearly traced out in the Vienna and Kew curves during the two hours. These disturbances are all so very small, that but for the comparison of photographs they would probably be lost sight of; yet we see that the same deflections occur at the same instant at Kew and at Vienna, at St. Petersburg and at Melbourne. From the remarkable similarity in these disturbances and their occurrence at the same time, we should expect that the cause of disturbance is so far removed from the places of observation that the difference of their distances from it need not be considered. This might not unreasonably be urged as an argument in support of a theory that such disturbances are due directly to the action of the sun regarded as a magnetic body. The numerical comparisons of observations made every five minutes on certain days previously fixed upon would probably never have shown the way in which these minute changes of magnetic power of the earth at widely distant places are related to one another.

In one or two cases Señor Capello and Prof. Balfour Stewart had compared the Lisbon and Kew curves for a particular disturbance, but the photographic magnetic records have never before been collected from other stations, and there has been no opportunity of comparing them. From the precise similarity of the forms of the curves in many cases we may say that the *rate of change* of magnetic disturbances at widely distant stations is the same. There is nothing fitful or flashing in such disturbances as these of March 26. We might imagine a current in the crust of the earth or a current or transfer of electricity in the air near to, *i.e.* within twenty or thirty miles of each of these observatories, but to imagine the same current and the same variations of the current at so many different stations, all changing in the same way at the same instant, is difficult, unless it can be shown in what way all these changes are connected with the cause of such a regular electric discharge. It seems easier to imagine that such changes as these are due to a change produced by induction in the magnetism of the earth itself by some distant body. It is easy to show that the magnetism produced by a current in a magnetic substance round which it flows is greater in its action on a small magnetic needle than the direct action of the current itself. Hence a current flowing in the crust of the earth should produce its principal effect on a magnetic needle by the magnetic induction which the current induces in the earth itself.

Sometimes disturbances occur where at the same instant there are similar deflections of the declination needles at stations wide apart, and suddenly at one of the stations the needle no longer goes with the others, but begins to go, and continues for a considerable period to go, in the opposite direction to the others, turning when they turn, and tracing out a similar curve, but turned always in the opposite direction. Such cases occurred frequently during March, 1879, and especially on March 23, about 1.30 and about 7 p.m., Kew time, and on March 29, about 9 p.m. An examination of the principal disturbances seems to show that:

(1) A diminution in the horizontal force is accompanied by greater easterly deflections of the declination needle at St. Petersburg than at Kew.

(2) Increase of the horizontal force is accompanied by greater westerly deflections at St. Petersburg than at Kew, or is sometimes accompanied by a westerly deflection at St. Petersburg and an easterly deflection at Kew.

These cases which I have taken will be sufficient to show how important it is that there should be additional magnetic observatories, especially in the southern hemisphere, where photographic records should be taken, so that we may learn something about the magnetism of the earth. Practically we have to rely on one excellent observatory (Melbourne) for the whole of the southern hemisphere. Surely the time has arrived when there should be photographic registration of the magnetic elements at such an important observatory as the Cape of Good Hope, especially when the French Government has decided within the last few weeks to establish a magnetic observatory at Cape Horn. With observatories at Melbourne, at Cape Horn, and at the Cape of Good Hope, the southern hemisphere would be well supplied, and probably the Russian Government would then soon establish an observatory in the east of Siberia.

Now we can readily show the way in which the magnetic instruments are disturbed in a magnetic observatory by the alteration of the strength of a magnet. Taking magnetic needles to represent the declination needle, the inclination needle, and the bifilar or horizontal force needle, we may place an electro-magnet in a given position with regard to them, and by altering the strength of that electro-magnet may cause these needles to trace out disturbances of a very decided character. In the disturbance of March 26 the greatest motion of the needle was not more than about 2′ of angle at Kew or at Vienna. It would not be possible for me to show you the action on so small a scale.

I have as yet been speaking of only moderate disturbances, but now let us come to some of the larger ones, and I have had the opportunity, through the kindness of the Kew Committee, and the observers at the various observatories mentioned, of studying the curves for the August magnetic storm which began at 10.20 a.m. Greenwich time, on August 11th, and for convenience may be divided into three storms, one lasting from 10.20 on the 11th, to 1 a.m. on the 12th; a second from 11.30 a.m. on the 12th to

7.20 on the 13th; and the third from 11.50 a.m on the 13th to 7 to 8 a.m. on the 14th of August.

I have prepared a large sheet, on which these curves have been copied as accurately as possible for the first of these storms on the 11th. For this storm I have also the curves from Toronto and from Zi-ka-wei. The first storm began on August 11 at the same instant at all the stations. There is a decided similarity, especially in the horizontal force curves, throughout the first part of this storm, and certain points in it stand out prominently. At Kew, the beginning of the storm is not actually recorded, because the sheets of prepared paper on the time cylinders were changed precisely at 10 20 a.m. when the storm was beginning. The deflections are alike at Lisbon, Kew, Vienna, St. Petersburg, and after the very first sudden deflection, at Toronto also. The greatest effect is produced at St. Petersburg; the similarity between the large disturbances at Vienna and at Toronto in Canada, places differing about 6½ hours in time, is remarkable. About 11.45, 1 p.m., and 2.40 p.m., there are very remarkable points of agreement.

From about 4.30 p.m. to 8 p.m. Greenwich time, *i.e.*, from about 11 a.m. to 2.30 p.m. Toronto time, the deflections are opposed at Toronto, and at Vienna or Kew.

This would rather point to solar action as the cause of disturbance. In this case the Kew curve is not so much deflected as the Vienna curve, because the horizontal needle at Kew is not nearly so sensitive as at Vienna, and the relative strengths of the actual disturbing forces at the two places can only be obtained by comparison of the scale-values at the two places.

I will draw your attention to one other point on this day. At 9 p.m. the disturbances are all in the same direction, but about 11 p.m., whilst St. Petersburg agrees in direction with the others in a very violent phase of the storm, at Toronto the direction of the deflections is reversed, and this reversal of curves continues until about the end of the first of the three storms.

The second storm, beginning about 11.30 a.m. on the 12th, and lasting until the next morning, was the most remarkable of the three. It not only baffles the telegraph clerks, who wish to keep out earth currents from their lines, but it even goes beyond the powers of the magnetic observatories which are specially designed to watch over them. Thus, at Toronto, the line goes off the edge of the paper on which the photographic record is taken. At Melbourne the motion is so rapid, and also at Vienna, that the plate is not sensitive enough to receive the impressions; the motion is too quick even for photography. At the time of greatest disturbance, about 12.20 midday, it is very remarkable that at Lisbon, and at Zi-ka-wei, near Shanghai in China, two places nearly in the same latitude, but nearly nine hours apart in time, the vertical force is increased in precisely the same way and to the same amount at the same instant.

At Zi ka-wei in China, the sudden change in the horizontal force on the needle amounted to about $\frac{1}{10}$th part of the total horizontal force, and at St. Petersburg the change in the horizontal force amounted to $\frac{1}{30}$th part of the horizontal force, and the total force was changed by about $\frac{1}{80}$th part of its full value.

Hence, any cause for these magnetic changes, in order to be a true and sufficient one, must be capable of producing such intense magnetic changes as these all over the surface of the earth. These magnetic changes are so large as to be quite comparable, as we see, with the earth's total force, so that any cause which is shown to be incompetent from the nature of things to produce the one can hardly be held to account for the other.

Since, as I have shown, the large disturbances and the small disturbances do not follow totally different laws, but agree equally well all over the earth, in so far as they agree we must attribute them to the same cause.

During this August storm, as also during the remarkable storm of January 31 last, great difficulties were experienced in working the telegraph lines, and Mr. Preece has been kind enough to send me particulars of these storms.

I am also greatly indebted to the Astronomer-Royal for sending me traces of the earth-current photographic records taken at Greenwich Observatory during the August storm on two separate wires, one running from the north-east, and the other from the south-east, to Greenwich. The two tracings are bent opposite ways at the same time, so that when a current was running on one line towards Greenwich, on the other it was running away from it, and comparing these curves with the earth-current records from Derby and Haverfordwest and other places, it appears that the general direction of currents during this storm was from south-west to north-east, or from south-south-west to north-north-east, with varying intensity, the agreement being very close between the disturbances of the declination needle and the Blackheath and Greenwich photographic record. From Mr. Preece's record also earth-currents were violent from 10.30 a.m. on the 11th (*i.e.* they were noted within ten minutes of the beginning of the magnetic storm) to about 2.30 p.m., and again from 9 to midnight.

They were very violent on August 12, beginning at 11.30 a.m., the beginning of the second storm, and quieting down about 4.30 p.m., then beginning again at 7.30 and lasting until 9.30 p.m.

Again on the 13th they are strong for 1½ hours, from about 5 in the morning, *i.e.* just about the end of the second magnetic storm.

The general direction of the earth-currents as observed at Derby or Haverfordwest, as well as at Greenwich, was from north-east to south-west.

Again on January 31 last another violent magnetic storm occurred, in which the currents were even more violent than in the August storm.

Intimately connected with magnetic disturbances and earth currents is the phenomenon of the aurora or polar light, which is an electric discharge in the upper regions of the atmosphere. During the August and January storms the aurora was well seen in England; it was also seen at St. Petersburg, and as far east as Siberia. It does not appear to have been seen, although it was looked for, at Zi-ka-wei in China by M. Dechevrens, the director of the observatory, although the magnetic storm was so violent there that the horizontal force was suddenly changed by $\frac{1}{10}$th part of its total amount.

We may arrive at some idea of the character of the aurora by studying electric discharges in vacuum tubes, and Dr. De La Rue has already brought this subject before you in his Friday evening lecture.

We may gradually pass from electric discharges in air of ordinary density, in which we get the well-known electric spark between two surfaces, to air of less density but better conducting power, and then to air of less density still, but of such high resistance that no electricity will pass. Dr. De La Rue has shown that with 11,000 cells of his battery the striking distance between two points is about six-tenths of an inch in air of ordinary density of about 760 mm. pressure.

When the pressure in a hydrogen tube is reduced to 21.7 mm. 8,937 cells will cause a discharge to take place through thirty inches.

When the pressure is reduced to ·642 (about six-tenths of a mm.), 430 cells will cause a discharge through the tube.

When the pressure is still further reduced to ·0065, it requires 8,937 cells to cause the discharge, so that the spark passes more readily at a pressure of ·642 mm. than it does at a higher or a lower pressure. This is also the case with air.

The lower regions of the earth's atmosphere offer great resistance to the passage of electricity, but as we ascend the pressure diminishes and the electric resistance diminishes, until at last, at a height of between thirty and forty miles, a level is reached where the air offers least resistance to the passage of electricity, where the pressure is about ·397 of a mm., and above that level the electrical resistance again increases, so that at a height of about eighty miles the battery of 11,000 cells would not cause a spark to pass.

If we take a tube which has not been very highly exhausted we see that the light from the positive pole extends nearly through the tube, and the dark space around the negative pole is small. As the exhaustion proceeds and the pressure of the air is diminished, the electric spark passes through greater and greater lengths and changes its character, until we get to the pressure corresponding to the least resistance. Beyond that the resistance increases, the dark space around the negative pole expands and the molecules fly about more freely; those on the negative plate being charged with electricity, and being repelled from it proceed for a long distance in straight lines, and possess the power of causing bodies on which they strike to glow. In Mr. Crookes's tubes we get very beautiful effects from this glowing of the glass tube itself, or from the glowing of substances in the path of the stream. We may regard this as a stream of molecules of gas charged with electricity, and we see the difference between this stream and the electric current in a vacuum tube at lower exhaustion by the action of the magnet upon it. In one case the current going through the molecules from pole to pole in the tube is bent out of its course by the magnet, and symmetri-

cally by the two poles, and returns to its path, the line of least resistance, through the molecules, whereas the stream of molecules at the higher exhaustion, carrying their electricity with them, are carried away by the electric charge upon them, and get utterly lost and scattered on striking the side of the tube, yielding up a great deal of energy in the form of heat to the tube or to the glowing platinum or other substance in the tube.

I must now show you the beautiful aurora tube which has been seen once in this theatre, and for which I am indebted to the kindness of Dr. De La Rue. It has been brought to the right state of exhaustion to show just those effects which will help better than any description of mine to give you an idea of the character of the aurora discharge in the middle regions of the atmosphere.

By bringing a magnet to bear upon this discharge we may see the effect of terrestial magnetism on the aurora discharges in the atmosphere.

Aurora Borealis.—The aurora as seen in the north-eastern parts of Siberia, where it is often very brilliant, is described as consisting of single bright pillars rising in the north and in the north-east, gradually covering a large space of the heavens; these rush about from place to place, and reaching up to the zenith, produce an appearance as if a vast tent was spread in the heavens, glittering with gold, rubies, and sapphires.

More exact attempts have been made to describe the aurora, and perhaps I may be allowed to quote Dalton's description of an aurora as seen by him.

A remarkable red appearance of clouds was noticed in the southern horizon, which afforded light enough to read by, and a remarkable effect was expected. He says, "There was a large luminous horizontal arch to the southward, and one or more concentric arches northward. All the arches seemed exactly bisected by the plane of the magnetic meridian. At 10.30 streamers appeared in the S.E. running to and fro from W. to E.; they increased in number, and approached the zenith, when all of a sudden the whole hemisphere was covered with them, and exhibited such an appearance as baffles all description. The intensity of the light, the prodigious number and volatility of the beams, the grand intermixture of all the primitive colours in their utmost splendour, variegating the glowing canopy with the most luxuriant and enchanting scenery, afforded an awful, but at the same time a most pleasing and sublime spectacle. But," he adds, "the uncommon grandeur of the scene only lasted one minute. The variety of colours disappeared, and the beams lost their lateral motion, and were converted, as usual, into the flashing radiations; but even then it surpassed all other appearances of the aurora, in that the whole hemisphere was covered with it."

In his address before the British Association in 1863, Sir William Armstrong speaks of the sympathy between forces operating in the sun and magnetic forces on the earth, and notices a remarkable phenomenon seen by independent observers on September 1, 1859

"A sudden outburst of light, far exceeding the brightness of the sun's surface, was seen to take place, and sweep like a drifting cloud over a portion of the solar surface. This was attended with magnetic disturbances of unusual intensity, and with exhibitions of aurora of extraordinary brilliancy. The identical instant at which the effusion of light was observed was recorded by an abrupt and strongly-marked deflection in the self-registering instruments at Kew. The magnetic storm commenced before and continued after the event."

The daily and yearly periods of the magnetic changes, the change in the horizontal force depending on the sun's rotation on his axis, the agreement of the eleven-year period of magnetic disturbances, sun-spots, and auroras, show that the sun plays a very important part in causing or governing both the regular and irregular magnetic changes.

If the sun be assumed to be a very powerful magnet, then changes in his magnetism might be expected to affect the magnetism of the earth, although the effect could not be very large, unless the sun is magnetised to an intensity much greater even, compared to his mass, than the earth is magnetised. Then as there are tides in the sea around us and probably in the earth's crust, so there are certainly very large tides in the ocean of air above us: and may not the sun and moon, by dragging this air towards them as the earth revolves, cause that friction between air and earth, and also that evaporation, which together may account for the presence of, and keep up the supply of, positive electricity in the air and negative electricity in the earth? Again, these tides in the atmosphere will cause the mass of it to lag behind the revolving solid earth, and at a height of thirty or forty miles we have a layer of air which, for air, is a comparatively good conductor of electricity. Here then we have not a lagging of the magnet behind the conductor, but a lagging of the conductor behind the magnet, and hence, according to the laws of Faraday, we may expect a current or a gradual heaping up of electricity in the air in the opposite direction to the current in the earth's crust. Thus the regular tidal waves in the atmosphere would cause the gradual transfer of positive electricity from the poles towards the equator. This transfer may be of the nature of a current of electricity or of a mass of air carrying a static charge of electricity with it, for as Prof. Rowland has shown that the motion of a static charge will produce magnetism, so we may expect from the principles of conservation of electricity that a change in the position of a magnet will under such circumstances produce motion of the static charge of electricity. When the air becomes charged up to discharging point, then we may get the sudden discharges such as the aurora in the air and the earth current in the earth; and since the conducting layer of air approaches nearer to the earth in the colder polar regions, possibly within less than twenty miles of the earth's surface, it may be found that the discharge of the aurora may even take place from earth to air by gradual slow discharge, aided as it may be by the state of moisture of the air and by change of temperature and other causes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—W. H. Caldwell, B.A., of Caius College, has been nominated to study at the Zoological Station at Naples.

Mr. F. M. Balfour, F.R.S., has been elected President of the Cambridge Philosophical Society. Prof. Newton in laying down the office referred with pleasure to the removal and the change in the management of the Society's library. Since the transfer to the new room about 500 volumes have been presented to the library by Professors Humphry and Newton, Mr. J. W. Clark, Mr. F. M. Balfour, and Mr. Horace Darwin.

Open Scholarships for Natural Science have been offered by Trinity College (date of examination, March 22 next); subjects those of the Natural Science Tripos; by St. John's College, subjects, Chemistry, Physics, Physiology, with Geology, Comparative Anatomy, and Botany (the last three only if notice be given beforehand), date, March 22; by Caius College, date March 28, subjects, Chemistry, and either Biology or Physics; by Christ's, Emmanuel, and Sidney Sussex Colleges, at a common examination; subjects, Physics, Chemistry, Biology, and Geology; date March 28.

UNIVERSITY COLLEGE, LIVERPOOL.—The Council of the College have appointed Dr. W. A. Herdman to the professorship of natural history, founded by Lord Derby in connection with University College. Dr. Herdman is a graduate of the University of Edinburgh. He took the degree of Bachelor of Science in 1879 in the department of Natural Science, and in the same year was intrusted by Sir Wyville Thomson with the preparation of the report on the collection of Tunicula obtained during the *Challenger* Expedition. The Council have also appointed Dr. J. Campbell Brown to the professorship of chemistry in the same college. Dr. Campbell Brown has for several years held the office of borough and county analyst, and of lecturer upon chemistry at the Royal Infirmary School of Medicine.

DR. ALEXANDER BAIN, lately Professor of Logic at Aberdeen, has been elected Lord Rector of that University.

SOCIETIES AND ACADEMIES

LONDON

Anthropological Institute, November 8.—Prof. W. H. Flower, F.R.S., vice-president, in the chair.—The following new Members were announced:—Miss Becker, Mrs. R. Crawshay, Mrs. Lloyd, Miss Mary Sheldon, Miss Eleanor E. Smith, Miss Wolfe, Prof. Acland, F.R.S., James Backhouse, William Bowman, F.R.S., Alfred T. Brett, M.D., Rev. H. Canham, John G. Garson, M.D., Hugh T. Hall, F.G.S., Capt. Hozier, W. J. Knowles, E. Llanfair Lewes, Alfred Lingard, M.B., G. D. Longstaff, M.D., William Parkin, H. Seebohm, F.L.S., Mark Stirrup, F.G.S., H. Stopes, F.G.S., Richard Thompson, Prof. E. Perceval Wright, F.L.S.; also Dr. Josef Majer of Cracow as a Corresponding Member.—Dr. J. G. Garson exhibited some improved forms of anthropometric instruments.—Mr. Everard

F. im Thurn read a paper on the animism of the Indians of British Guiana. After defining animism as belief in the existence of spirit in any form, the author stated that the animism of the Indians of Guiana, in common probably with that of many other American tribes, is not only of an exceedingly pure and rudimentary kind, but is much more primitive than has yet been recognised by students of religious evolution. The Indian belief is that each object and phenomenon of the visible world consists of body and spirit; and these countless dual beings differ from each other only in bodily form and in the degree of brute force or cunning which they possess, but are none of them distinguished by the possession of any sort of divine character. There is no belief, of genuine Indian origin, in gods or a God, in heaven or hell, or in reward or punishment after death; nor is any form of worship practised. The author also indicated how in this belief may be found the germs from which all the features of the higher religions have arisen by modification.

PARIS

Academy of Sciences, November 7.—M. Wurtz in the chair.—The following papers were read: -On the limits of electrolysis, by M. Berthelot. In the electrolysis of sulphate of potash (as also of haloid salts), the smallest sum of energies capable of working the decomposition is far below that which would be required for the previous setting at liberty of the alkaline metal. It is equivalent to the separation of the acid and the base, plus either the separation of the oxygen and the metal at expense of the base, or the decomposition of the acidulated water.—On the combustions effected by bioxide of nitrogen, by M. Berthelot. The property of burning at expense of bioxide of nitrogen under influence of a flame or electric spark, depends mainly (the author shows) on the temperature developed. Of the mixtures tabulated, none that develop a temperature theoretically under 7000° are inflamed; while those developing a higher temperature burn or detonate.—Synthetic experiments in artificial reproduction of meteorites, by MM. Fouqué and Lévy. By igneous fusion they have obtained bodies closely resembling some oligosideric meteorites; one type containing felspathic products, and another not. The former contains anorthite associated with pyroxyene and enstatite (eukrite) or peridote (howardite); the latter peridote, enstatite, oxydulated iron, and a pyroxene exclusively magnesian.—Solution of two questions of maritime hydraulics, by M. Cialdi. One refers to the force governing the sand of banks and harbours; (Cialdi's theory that the undulatory motion is the prime force is now accepted, as against that which puts the littoral current first). The other refers to the method of construction of moles for harbours by the Romans; (they did not make these with apertures where there was exposure to the open sea).—On the comparison of the waters of the Isère and those of the Durance in their hydrographic and agronomic relations, by M. de Gasparin. He controverts some views of M. Dumont.—Report on a memoir of M. Leauté on teledynamic transmissions. The author's solution of the problem is pronounced complete, theoretically and practically.—On silica and silicates of lithine, by MM. Hautefeuille and Margottet. *Inter alia*, three new crystallised silicates of lithine have been obtained (by means of chloride of lithium in fusion), and it is proved that silica may take the form of quartz in presence of a fused chloride.—On the means to employ for destroying the winter-egg of phylloxera, by M. Mayet. He considers it best to operate where the vines have every year galls on the leaves, and to treat (with insecticide) only the wood of two or three years.—A work by M. du Bocage (Lisbon) on the "Ornithology of Angola" was presented.—Elements of Denning's comet (1881 *f*), by M. Schulhof.—On a general formula for development of the principal part of the perturbative function, by M. Baillaud.—On the reduction of Abelian integrals, by M. Picard.—On linear differential equations, the integrals of which verify relations of the form $F[\phi(x)] = \psi(x)F(x)$, by M. Appell —On the integration of an equation with partial derivatives of the second order, by M. Teixeira.—Mode of transmission, in an isotropic solid (in equilibrium) of the pressure exerted on a very small part of its surface, by M. Boussinesq.—On the possibility of electric equilibrium, by M. Lévy.—On the product and the limit of operation of the transport of force by electricity, by M. Lévy.—Articulated systems, giving rectilinear motion or circular curvature, by Prince Gazarine.—Experimental method of determination of the ohm, by M. Lippmann.—Action of cold on the voltaic arc, by M. Tommasi. He used as rheophores, copper U-tubes (placed *vis-à-vis* horizontally), through which ran cold water. The luminous power is considerably weakened; the arc is very unstable; it does not ignite paper held 0·004m. above it; it is very mobile, and its form is like that of a drop of liquid in the spheroidal state; it is attracted and put out by a magnet; and there seemed to be more ozone than when the arc is not cooled. The flame was slightly green.—On an electric method for determining, with a needle, the position and depth of a projectile, or other metallic substance, in the human body, by Prof. Bell. A fine needle, connected by wire with a telephone, is inserted; and a metallic plate, similarly connected, is applied to the skin. A sound is heard when the ball is reached. A trembler may be introduced into the circuit giving a musical note in the telephone on contact of needle and ball; a battery may also be included.—New demonstration of Riemann's theorem, by M. Croullebois.—The direct-vision spectroscope with calcareous spar, by M. Zenger. He combines a single prism of spar of 75° refringent angle, with a fluid prism (sulphide of carbon, oil of cassia, or other liquid) of the same angle. The dispersion is very great. The red image of the protuberances can be obtained with great intensity, there being small loss by absorption and none by reflection.—On the function which expresses the gaseous state, by M. Gouilly.—On cuproso-cupric sulphite, by M. Etard.—On a hydrate of chromic bromide, by M. Varenne.—Action of hydracids on alkaline chromates, by M. Varenne.—Reply to M. Debray on dissociation of sulphydrates of ammonia, by MM. Engel and Moitessier.—On the vapour-tensions of carbamate of ammonia, by M. Isambert.—Modifications of composition of green fodder kept *en silo*, by M. Lechantier. Maize and trefoil lost a little of their azotised matter, but the loss of glucosides was much greater; the chief loss being now in the glucose and sugar group, now in the starch and cellulose. Fatty matter increased.—Artificial peridote produced in presence of steam, at ordinary pressure, by M. Meunier.—Action of hydriodic acid on chloroiodide of propylene and on chloride of isopropyl, by M. Silva.—On the contagion of tuberculosis, by M. Toussaint. *Inter alia*, tuberculosis becomes more powerful and rapid in its action the oftener it is inoculated.—On the physiological action of codethyline, by M. Bochefontaine. This action seems to consist in an exaltation of the reflex properties of the grey substance of the bulbo-medullary nerve-centres.—Contribution to a study of Flagellata, by M. Kunstler. He has found an organism very like noctiluca, but living in fresh water.—Observations on rotators of the genus *Melicerta*, by M. Joliet.—On the vitality of germs of *Artemia salina* and *Blepharisma lateritia*, by M. Certes.—On the winter spores of *Peronospora viticola*, by M. Prillieux.—Discovery of gypsum in the strata of the superior Eocene formation of Peru, by M. Caraven-Cachin.—On the characters of speech in deaf-mutes taught to articulate, by M. Hément. He maintains that these persons have the accent of their country, indicating organic conformations similar to those of their parents. M. Blanchard disputed this.—On the spontaneous insensibility of the sensitive plant, by M. Musset. A sudden fall of temperature suspends spontaneous movements of the plant (as chloroform, &c., suspend provoked movements)

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ERRATUM.—Vol. xxiv. p. 509, in the letter of Prof. Alex. Agassiz, for *Polydonia* read *Polyclonia*

THURSDAY, NOVEMBER 30, 1881

ANTI-VIVISECTION *versus* HUMANITY

THE physiology of the brain is a subject which has long been matter of much speculation and of some experiment, but till twelve years ago little was known about it. The experiments of Flourens and others had taught us something about the functions of the cerebellum, and Broca's observations on disease had led him to localise speech in the third left frontal convolution; but with these exceptions the functions of the different parts of the cerebrum were almost entirely unknown; although, as a whole, it was regarded as the organ of thought. The experiments of Fritsch and Hitzig, published in 1870, showed that the cortex of the brain could be excited by galvanic currents, although mechanical irritation seemed to have no effect upon it. When certain parts of the cortex were thus irritated in the dog, definite movements of the paws ensued.

In a series of experiments published in the West-Riding Asylum Reports for 1873, Dr. Ferrier confirmed these results, and greatly extended them by experimenting on guinea-pigs, rabbits, and cats, as well as by investigating more fully and precisely the various areas in the brain of the dog. Dr. Ferrier's most brilliant discoveries were due, however, to the happy thought of using monkeys as the subject of experiment. For though a general resemblance can be traced between the functions of different parts of the brain in rabbits or dogs, and in man, yet the brains of these animals are so little developed in comparison with that of man, that exact and definite conclusions regarding the human brain cannot be drawn from experiments on them. Monkeys resemble man more closely than quadrupeds in the more or less erect posture which they tend to assume, in the use of their hands and fingers as prehensile instruments, and even in their muscles of expression. Their brain, though less complicated than that of man, still corresponds closely with it in the general arrangement of the convolutions, and even in many details.

Dr. Ferrier's experiments were performed by anæsthetising the animal and removing a part of the skull so as to expose the brain. The animal was then allowed to recover either partially or completely from the anæsthetic. On the brain being stimulated by touching it with the wires of a battery at various points of its surface, definite movements resulted. A touch on one part, for example, would cause the animal to stretch out its paw as if to grasp some fruit, on another to raise its hand to its mouth, as if to convey the food into it, and another to move its mouth and tongue as if chewing. These motor areas were chiefly around the fissure of Rolando, towards the anterior part of the brain. Stimulation of the posterior parts appeared to cause sensation (not pain), a touch on one part causing the animal to look round as if it saw something unusual, on another to prick up its ears as if it heard something, and on others to move the nostrils and mouth as if it perceived some unusual smell or taste. Destruction of the surface of the brain at the parts whose stimulation caused movement resulted in the impairment or loss of the power of executing the corresponding movement voluntarily, and where stimulation caused sensation the destruction of the part diminished or destroyed the corresponding sensation of hearing, sight, or touch.

These experiments might seem at first sight necessarily to involve the infliction of great pain, and some unthinking people have loudly cried out against what they call horrid cruelty, and have denounced the experiments in no measured terms; yet the fact is that the animals experimented on suffer very little pain, and probably a single sportsman in a day's pheasant-shooting inflicts more pain than Dr. Ferrier has done in the whole course of his researches. Every one will understand this who has seen a child hurt its finger and cry bitterly for a few minutes, and then run cheerily about as soon as the wound was bound up.

The painful part of Dr. Ferrier's experiments, viz. the exposure of the brain, was performed under anæsthetics, and when the animals were allowed to recover they exhibited no signs of pain. Stimulation of the surface of the brain, even on the sensory areas, does not seem to cause pain. The effect of stimulating the motor areas and thus causing movements of the limbs in monkeys, appears to be simply to excite their wonder and curiosity at the extraordinary circumstance of their limbs moving independently of their volition.

The localisation of function in the brain is of exceeding interest as a simple addition to our knowledge of the wondrous mechanism of the body, but it is also of very great use in practical medicine. By means of it we are able to say, with considerable certainty, that the lesions which give rise to particular groups of symptoms are situated at this or that point in the brain. Ferrier found, for example, that stimulating one part of the brain would cause movements of the hand, ending in clenching of the fist, and if the stimulation were continued for a long time other muscles were involved, until at last the animal fell into an epileptic fit. Previous to Ferrier's researches we were in the dark regarding the origin of epileptic fits in man, but now when we find a fit beginning with clenching of the fist we can with considerable certainty localise the cause of it in a definite region of the brain. Not unfrequently epilepsy comes on after a blow or fall on the head, and may continue for months or years, completely ruining the patient's prospects, and perhaps ultimately destroying his intellect. In such cases the disease has been cured by the removal of the injured portion of skull; but before the researches of which we have been speaking showed how to localise the injury, this was impossible, except immediately after its inflection, and while the evidences of its position were unmistakable. Now, however, thanks to Dr. Ferrier, it is possible to operate successfully long after the injury, as the following case, which we extract from the *British Medical Journal*, will show:—

"A child, aged seven, received a blow from a poker; it produced no external wound, and no scar or depression of bone remained. A year later the child had an epileptic fit, and continued to have fits daily for about seven years, with occasional periods of exacerbation, at which time the fits increased to twenty or thirty a day. At the end of this time Dr. Ferrier was asked to see the child in consultation; tenderness was found over the right parietal region, with loss of power in the left hand and indistinct utterance from loss of muscular power in the lips. Trephining was decided upon, and Dr. Ferrier pointed out that the seat

for trephining should be rather low down, to correspond to the centres for the arm and lips, which seemed affected. This was done; for eight weeks after the operation the child was free from fits, and at the periodical exacerbation the fits returned with always diminishing severity."

We have given only one instance, but Dr. Echeverria has collected 165 cases of traumatic epilepsy, of which 64 per cent. were cured by trephining. Nor is it only in epilepsy that operative procedure, directed by the knowledge gained from Dr. Ferrier's researches, is useful. In abscess of the brain it guides the surgeon's knife to the spot where the pus has accumulated, and even when disease is due to tumours, it indicates their site, and enables them to be removed and the patient cured, as in a case reported in the *Glasgow Medical Journal*. It opens a new region in the treatment of diseases of the brain, of which it is impossible at present to see the limits; and when we consider how recently the discoveries have been made it seems extraordinary that they should have already been productive of so much benefit. Operations on the head are not however to be rashly undertaken, and in Dr. Ferrier's first experiments he found that injury to the brain was apt to spread beyond the primary limits of the lesion. Prof. Yeo therefore commenced a series of experiments for the purpose of discovering how far improved methods of operating would obviate the risk incurred in such operations, and his attempts have been very successful. These operations were carried out with a proper licence and certificate under the Vivisection Act. Dr. Ferrier embraced the opportunity of observing these animals, and aided Prof. Yeo by his advice, so that each experiment was utilised for the purpose of increasing our knowledge of localisation, and thus aiding diagnosis, as well as of improving the mode of treatment. For these observations he was summoned before the police-court last week by the Society for the Protection of Animals from Vivisection, on what grounds it is difficult to see. Though the summons was dismissed by the magistrate, the prosecution no doubt caused much worry to Dr. Ferrier, and might have caused expense, were it not that the British Medical Association took up and defended the case, in order to show its appreciation of the value of Dr. Ferrier's services both to medical science and suffering humanity. It is now about five years since the Vivisection Act was passed, and the late prosecution of Dr. Ferrier, while it shows how carefully the Act has been observed by physiologists, affords evidence that an Act which purported to be for the prevention of the abuse, is being converted into an instrument of annoyance to those who are best qualified for the use of experiments on animals. At the time the Act was passed many persons objected to it, on the ground that it was quite exceptional to legislate against an abuse which had never been proved to exist in this country. It has been shown by many statements made in the medical journals within the last few months that the Act is being administered in such a manner as seriously to interfere with the progress of science; and it seems not unlikely that the present insult to one of their number may rouse the medical profession to combined agitation against restraints on research for the acquisition of that knowledge which may enable them to lessen the sufferings or save the lives of their patients.

EGYPT OF THE PAST

The Egypt of the Past. By Erasmus Wilson, F.R.S. (London: Kegan Paul, Trench, and Co., 1881.)

THE increased interest taken in Ancient Egypt has produced of late two new histories in English, and two in French and German. The English histories are last in the field, and are those of Prof. Rawlinson and Sir Erasmus Wilson. These histories are not really the work of Egyptologists or experts like that of Brugsch Pacha and M. Maspero, but are attempts to produce readable works for popular purposes by writers interested in Egypt or writers of history, and have consequently all the merits and defects of that kind of way of treating the subject.

The present article is devoted to a consideration of the work of Prof. Wilson, which has last appeared, and is exclusively devoted to history. It comprises the history from the oldest days, the first appearance of the primitive Egyptian, the aboriginal of the Nile, till the last of the Pharaohs, the miserable Nectanebo, who abandoned his country, but not his wealth, to the foreigner B.C. 345, and from that time till to-day a foreigner, in accordance with the law of monarchical nations, has ruled the country with the usual results.

The question of the first man of the Nile has not yet been settled, and he was probably one of those types which have disappeared from view altogether, and belongs to the fossilised remains of the planet. But history has little to seek about the prehistoric races and evidence of an antecedent state of dawning civilisation; flint weapons are very scanty and obscure, and do not aid the solution of the problem The obscure period of "the followers of Horus" has no historical or chronological importance, and belongs to the hazy epoch known as mythical and immeasurable. Actual history, but not positive chronology, begins with Menes, and the facts ascribed to Menes are, according to historical criticism, such as can be accepted as credible.

It has been agreed to designate as the Old Empire that part of Egyptian history which glides from the first to the sixth dynasty. This comprises the Pyramid-builders, most, if not all, of whose geometric sepulchres are situated in the plains of Memphis and its vicinity on the western bank of the Nile. Although no pyramid can be identified with any king of the first dynasty, and the names of monarchs are known only from official lists and after-recollections, a monument of the second dynasty from a private tomb is in the Ashmolean Museum at Oxford, and shows that the civilisation at that remote period had attained the same excellence as at the fourth. It was under this dynasty that the worship of animals—an African idea—arose, and if the pyramid of Sakkarah, with its numerous chambers, was, as supposed, an early sepulchre of the Apis, that edifice must have been erected under the second dynasty, with all its geometric regularity and architectural knowledge, four centuries after Menes. Certainly writing, sculpture, painting, the arts and sciences had attained a great advancement and development. Still further advancement is visible under the third dynasty, and in the tombs which lie around the Pyramid at Meidoom sculpture had then reached a high excellence, and the portrait of the individual as well executed as the

Roman sculptor could produce it. The men were painted a kind of copper colour, the women yellow, like the Semitic races. The red tint appears later, and the lips at all periods seem to show that an infusion of black blood even at the earliest age had been transfused into the Egyptian race. Senefru or Senophris had already conquered the Arabian Peninsula of Mount Sinai and worked the turquoise mines of the Wady Magarah. Besides turquoise, however, copper slag has been found at the spot, but the *mafk*, an obscure word, sometimes apparently used for a light blue colour, is decidedly not copper. The Great Pyramids, however, are the work of the subsequent dynasty, whose history is chiefly an account of Pyramids and their construction, with an occasional notice of their builders, and the present work judiciously gives the history without the fallacious theories which have found favour with credulous enthusiasts.

Although iron weapons have not been found of the age of Cheops, a sheet of this metal was discovered in one of the air-passages, and a copper tool in another, and the name of one of the monarchs, Merba, "lover of metal," or "iron," occurs amongst the kings of the first dynasty. Except for monumental remains the history of the fourth dynasty is unimportant, although it kept up the conquests and mines of the Wady Magarah, and architecture and technical arts improved, while sculpture and portraiture continued their unrivalled career. With the fifth dynasty the interest begins to thicken, the Pyramids are no longer dumb stones unable to explain their appearances on the great Memphite plains. The presence of pyramids and obelisks had shown that there was a religious system; the inscriptions in the Pyramid of Phiops at Sakkarah, and those of his successor, show that the myth of Osiris and the cosmogonic ideas connected with it had already developed, while the passage of the soul along the starry heavens, and the constellations, especially Orion and the dog-star, prove that the eschatological notions of the period differed exceedingly from those of subsequent periods, while the ethical writers of the period herald the advent of philosophy. The sixth dynasty, the inscriptions on the pyramids of which have been recently discovered, follow the same ideas as the fifth dynasty. Sir Erasmus Wilson has now been able to avail himself of these recent discoveries of the texts of the tombs. After the sixth dynasty lists perhaps supply the succession, but there is a monumental gap till the eleventh, and thence from the twelfth—a fair succession. Thebes, Tanis, and Heliopolis supplant Memphis.

The fifth dynasty had no very important history, and that of the sixth only acquires importance from its enrolling negro troops for the purpose of its northern wars, and the religious inscriptions recently discovered in its Pyramids throw light not only on the earlier religion, but on the antiquity of the worship of the gods and their relative place in the religious system. The first dynasty after the sixth which has any history is undoubtedly the twelfth, although the tenth attempted to reach Punt or Somali, or Cape Guardafui—early evidence no doubt of sea-going ships on the Red Sea and eastern coast of Africa. The history of the twelfth dynasty, its obelisks, labyrinth, Lake Moeris, is well and fairly given, but no additional light is thrown on the period already well known from the monuments and the Turin Canon, and the Sallier and Berlin papyri. On the north this dynasty did not penetrate farther than the peninsula of Mount Sinai, transferring their search for turquoises and metals from the Wady Magarah to the Sarabout El Khadem in the vicinity. Distinguished as it is by the advance in the arts and sciences as manifested in the tombs of Memphis, Abydos, and Eileithyia, its principal features were the undying thirst for gold, and constant search for slaves in the South amongst the Negroes, and its fortifications over the South and North against Negroes and Asiatics. There is a fair account of the twelfth dynasty, but the history of that period is capable of some expansion. The obscure subsequent dynasties, especially the Shepherd rulers, various monuments and statues of whom have been found at Tanis, and are described in the writings of De Rougé and Mariette, are fairly given. Some further information might perhaps have been added, but there is enough to satisfy the lambent curiosity of the general reader. The history of the eighteenth dynasty is well known, and although the rich discovery of mummies at the Deir-el-Bahari has not added one iota to this period, it has confirmed some old ideas. It is certain that the queen of Aahmes I., called Aahmes Nefertari, "the good companion of Aahmes," was unequivocally black, and no sacred office could possibly wash that Æthiopian white. Black she was always painted, and an Erastian priesthood never attempted to whiten her face. The throne of Egypt under this dynasty was occupied not by one, but by a succession of mulattos, and there was no deficiency either of courage or intelligence in the monarchs who raised Egypt to the highest pitch of glory, and stretched the boundaries to the Euphrates, if not to India itself. Egypt, in fact, always had a great infusion of Nigritic blood in its population, more Semitic perhaps on the East and European on the West, but undoubtedly very Nigritic on the South, where the misegenation with the black races prevailed. The princes of Æthiopia, scions of the royal family, were no doubt at this time red Egyptians in their parentage; but there were then, as now, two kinds of Negroes, the black and the copper-coloured. Many of the male contemporaries of Cheops have a chocolate hue, which hardly agrees with a Caucasian origin. Sir Erasmus Wilson seems puzzled about the inscription at the base of the obelisk of Hatasu at Karnak; it did not dovetail in with chronological theories, so Lepsius assigned it to the "blundering stonecutter"; but later explanations solved the seven months, by showing that the kings dated their regnal years from their accession, and that the date of the accession fell within the seven months, and the seven months were in two regnal years, and that it was unnecessary to add twelve months to the calculation. This has been generally accepted by scrupulous chronologists only too anxious to play at figures, and it appears a natural one. No one need marvel at the rapidity of the work, as the wishes of tyrannical princes have always been carried out with a marvellous rapidity, without the least consideration for human life, much less of toil. The grandeur of the works of Thothmes III. at Karnak, his obelisks and his exploits, are given, but the ingenious capture of Joppa by a stratagem worthy of the pen of Polyænus, and the countries where Thothmes hunted the elephant, are not pointed out. India has been suggested,

and nearer than India on his eastern frontier he could not have found herds of this animal, while the Rutennu, a very Indo-Chinese looking race, brought as tribute to Egypt, in the reign of the great conqueror, the *white* elephant, painted red and white, with gilded ears and toes. Had the fame and terror of the Egyptian conqueror reached the confines of Burmah, and the princes of Indo-China propitiated the Egyptians with that expensive present, a white elephant. All this occurred about 1600 B.C., and eight centuries later, in the reign of Shalman er II., the elephant, as a rare animal, figures on the obelisk found at Nimroud depicted in a style far inferior to the Egyptian. The mutilated mummy of Thothmes has been found at the Deir-el-Bahari, and all that remains is inadequate to give an idea of his person. His successors came into conflict with the Khita, the supposed Hittites, but so did the Ptolemies long after the Hittite kingdom is supposed to have been extinguished. The account of the Pharaoh Khuenaten and the obscurity which prevails about the succession after that heretic, might have been enlarged, and a little more said about the Pharaoh Horus and the historical difficulties about his reign. The hypothesis of Brugsch Pacha, that he reigned twenty-one years, is plausible to superficial observation, but not acceptable on deeper reflection; but these are Egyptological points not in the absolute province of an historian, unless on separate independent philological research. The theory of Brugsch Pacha, that the invasion of Egypt by the Libyans was accompanied, not by Greeks and the people of the Isles, but by Colchian tribes from the Caucasus, although supported by ingenious philological reasons, is not accepted by Ebers and others, and is not entertained in the work. This account of the nineteenth dynasty and the route of the Exodus, it has been already pointed out, does not correspond with the physical conditions of the country or the late surveys, but then the original error is due to the French engineer whose hypothesis was too hastily seized on and proved with too much special pleading. The history of the twenty-first dynasty is only imperfectly known, but here the recent discoveries have thrown additional light on this obscure period. The mummies at the Deir-el-Bahari have aided in the determination of the succession, and it is evident that these high priests were not only descended from the Princes of Æthiopia, who, originally appointed by the Pharaohs, maintained a kind of hereditary succession, but also belonged to the black races, the flesh of Pinotem II. being unusually brown, and revealing a Nigritic descent, there was a strange similarity with the features of Khuenaten, who also probably appertained to the same race. The hypothesis that Shishak was an Assyrian king or prince is not confirmed by the annals of Assyria nor Nimroud, whose Egyptian name Namruth is supposed to have the meaning in the Æthiopian dialect of Panther. But the name of Nimroud is not yet identified either in the Assyrian or Babylonian, and although the names of Assyrian persons mentioned in Egyptian have little resemblance with those given by the Assyrians themselves, still ingenuity might convert Pul Ashar-nes into Assur-Nazir-Pal, who ruled some time about the period. The Æthiopian dynasty is given with some detail, but there is some difficulty about the Æthiopian Piankhi, who conquered the supposed dodekaroty or rulers, who presided over Egypt according to the Assyrian annals, and whose names are recorded on the historical cylinders of Assurbanihabla, or Assur-banipal, and enter into Egyptian history. The position of Piankhi is placed immediately before the twenty-sixth dynasty, on account of his having for antagonist Tefnekht or Tnephakhthus, the father of Bokkoris, king of the twenty-fourth line. But Piankhi's name occurs amongst the kings of the twenty-first dynasty, and Piankhi may have been placed too low in the series. The Æthiopian invasion of Egypt is amply detailed in the Assyrian annals, but the information of the Egyptian monuments about Sabaco and Tirhakah is scanty.

The "Egypt of the Past" may be safely commended to the general reader as containing in a lucid form all the contributions of monumental sources to Egyptian history; it is not too long nor detailed, and is in a portable form. The plates are very well executed, especially the woodcuts; the coloured lithographic ones are gaudy and hazy in the style of Turner, but as that is supposed to represent a kind of aërial perspective of the highest order, it will no doubt commend itself to æsthetic minds. It is, however, a good work, and well got up.

OUR BOOK SHELF

Natural Philosophy for London University Matriculation. By Edward B. Aveling, D.Sc. (London: Stewart and Co., 1881.)

WITH text-books innumerable devised specially for their use, it would be remarkable if candidates for the London matriculation should fail in natural philosophy. That so large a proportion should fail in this subject, as is the case, must be due not to the quantity, but to the quality of their sources of instruction. What then must be said of a teacher who takes upon himself to venture on the scene with an inferior and trashy work in which all the worst blunders of the exploded text-books of a past date are reproduced? Although the writer of the book lying before us professes his indebtedness to the excellent manuals of Dr. Wormell and Mr. Philip Magnus, and to the invaluable assistance of his friend Mrs. Annie Besant, he cannot be congratulated on his success in following in the tracks of his predecessors. His book is, in fact, a cram-book of the worst and weakest type. The barest minimum of the subject divided into the inevitable Statics and Dynamics constitutes the programme; Optics and Heat being somehow thrown in along with Moving Bodies as divisions of the latter of these two branches.

Passing over the Introduction, we arrive at the heading "Definition and Divisions," where the serious business of teaching natural philosophy begins with the words: "From its earliest years a child is surrounded by a world of beauty and of mystery," and the author proceeds anon to advance grave arguments for the conclusion "force, then, is the cause of motion." After this it is not very surprising to read (p. 165) that as the "phrase 'change of velocity' is cumbersome, it is replaced by the exceedingly important word 'acceleration.'" And then, as if the author were not sure whether to give us too little or too much in his definitions, we are told in the very next sentence: "Acceleration is the change of velocity per unit of time *that occurs in a unit of time*"! That this is no mere *lapsus calami* is clear from the next page, where it is twice stated that acceleration is the "change of velocity per second *that occurs in one second.*" Yet the author expressly states that "variable acceleration is not within our

ken in this book." The Second Law of Motion is given in the imperfect Whewellian instead of the perfect Newtonian form, in which all the best treatises on dynamics have given it since the salutary return to Newtonian precision was inaugurated by Thomson and Tait. On p. 198 the author proposes to measure gravity on an Atwood's machine, with a falling mass of one centigramme. Did he ever try the experiment? On p. 241 the student is told that the Torricellian vacuum is to be found in the space left by the mercury at the top of a *thermometer*! Under the heading of Calorimeters (which instruments, by the way, are nowhere described) the novice is informed that "Joule established the fact that 772 pounds of mass falling through one foot give out a thermal unit"; from which it would appear that heat is the product of a mass into a length. Bad as this is, it is pardonable beside a passage in the introductory part of the book (p. 10), in which the reader is assured that a force generates heat at the point of its application when the point of application does not move forward. One grows weary of gathering from the rank crop of blunders; but a final example—the very last sentence of the book—shows the accuracy of our author's physical knowledge as displayed in his theory of dew. "A tarpaulin spread over the ground, or nature's tarpaulin of clouds, will *reflect* the *radiating rays* (sic) of heat, and under the tarpaulin or clouds dew is not deposited."

"Let me start," says Dr. Aveling (p. 6), "with two truisms—(1) That no book is worth reading that is not worth analysing; (2) that the ideas enunciated by a teacher, either by voice or pen, are not thoroughly the ideas of the learner until they have been expressed again in his own words. If, therefore, that which I am about to write is in any sense useful, it will be worth the while of the student to make analysis thereof." What if the student's analysis throw unexpected light on the first of these truisms? S. P. T.

Der Völkergedanke im Aufbau einer Wissenschaft vom Menschen, und seine Begründung auf ethnologische Sammlungen. (Berlin, 1881.)

Die Vorgeschichte der Ethnologie. (Berlin, 1881.)

THESE two pamphlets, by Prof. Adolf Bastian, are written to promote the doctrine he is never weary of teaching, that the scientific method of studying man is the museum-method of collecting and classifying his results, whether these be weapons or idols, or myths or superstitions, or what not. When in a group of such things there comes into view a common principle or thought, this is a *Volksgedanke*, a manifestation of the popular mind, a definite something for the science of man to occupy itself about. It was the desire to get at such general principles of human action that led the late Prof. Waitz to compile his Anthropology, and Prof. Bastian has gathered, in the many volumes he has published, an even vaster museum of human facts. In the first-named of the two publications above, the reader will find collections of evidence as to many of the problems which are now occupying the minds of anthropologists, such as the primitive relations of the sexes, the development of the family and of property, and the belief in ancestral and patron spirits. The few lines of comment with which the author links together his pages of citations are of especial value, as giving his judgment of the meaning of the facts. In the second pamphlet the author traces the growth of anthropological museums out of the old cabinets of curiosities. Neither treatise is well suited to quote passages from, as these lose their value when disconnected from the rest, like single specimens taken out of the museum. Now and then Prof. Bastian makes a sort of holiday digression, for instance where he collects page upon page about modern European miracles, relics, and pilgrimages, about which he truly says, "the nature-peoples, with their rude, clumsy fetishes, are no match for the subtleties of super-refined civilisation" E. B. T.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Telescopic Definition in a Hazy Sky

THE diminution of star disks during temporary haze or even by a thin passing cloud has been particularly noticed by Sir John Herschel. The effect of this haze is apparently to diminish the intensity of diffraction phenomena. The markings on the full moon have never been seen so blackened and distinct as through the haze of a London fog. On one occasion a very gentle east wind brought down a London fog to Reading. That evening the air was extremely still, but embrowned with the haze. Castor bore a magnifying power of 600 with a Wray $5\frac{1}{4}$ achromatic. The object-glass was being adjusted to the axis of the tube. Finally an intense jet black ring was seen to surround each star of this celebrated double, supplemented with one bright perfectly defined diffraction-ring, then a fainter ring at a further distance could be descried. The perfection of this definition has never since been attained. The haze had settled down into still air. The eastern breeze had died away. The brown fog remained in the sky; diffraction assumed its most perfect form. The moon bore any power I could muster with absolutely steady definition. These states of the atmosphere are extremely rare. I can now record a repetition of this wonderful steadiness. On November 9 Col. Abadie, Mr. Maunsel, and myself, were observing Saturn with an $8\frac{1}{2}$ Calver mirror. The crape veil and belts were well shown with the pale blue Polar cap. Ball's division was intensely black. The outer ring was narrow, and its dark grey tint contrasted strongly with the brilliant whiteness of the inner ring. I was greatly astonished, however, to descry Encke's division on the outer ring usually called A. The shadows of the ball were well marked. The eastward shadow much stronger than the western. A very brilliant narrow band edged the northern belt near the plane of the rings. The inner edge of the ring B projected a thin shadow on the ball. A lady who had no previous knowledge of the belts, entering the observatory last night, said they appeared to consist of several fine lines of parallel bands separated by very fine brighter bands. At 11 p.m. there was a very wide narrow halo round the moon. Saturn appeared much bedimmed, and Jupiter shorn of his brilliance. Yet Col. Abadie writes: "Jupiter was a sight to be remembered. The distinctness of all the belts was enhanced by bright zones; one to the north of the uppermost belt was particularly to be noticed. The clouds between the equatorial belts changed in appearance from being very fleecy to a long wavy appearance" (we were observing about three hours). The moon was too dim for observation. Encke's division is so seldom seen in my experience, its appearance in the field of so small a telescope was a matter of great surprise; and but for the concurrent testimony of two others for about a space of three hours, I certainly should have greatly doubted the accuracy of the observation. At all events, it is a valuable demonstration of the value of the *chiaro-oscuro* in astronomical research.

Eastbourne, November 16 G. W. ROYSTON-PIGOTT

The Morteratsch Glacier

DURING my stay in the Engadine this summer I took the opportunity of making a few observations relative to the movement of the Morteratsch Glacier, which may be of interest to some of your readers. These observations were taken *inside* the artificial cave of the above glacier in preference to the surface, as I thereby obtained a more direct measurement with a fixed point, as will be shown presently, and greater protection for the provisionary stations, made in the ice, against disturbances of fluctuating temperatures or the curiosity of visitors. The arrangement was very simple, namely: in the roof of the cave 2—$\frac{3}{4}$ in. round staves 2 feet long were fixed, at a relative angle of 45°, in such a way, that they prevented each other from dropping out, and were further clamped together by a small metal band, from which a plumb-bob was

suspended. Below this, on the floor of the cave, was a boulder, firmly embedded in the earth, and unaffected by the ice; this constituted my fixed point, a line being cut on it to correspond with the centre of the bob. In this way any movement of the staves with the ice could easily be measured off. The following are some of the results obtained, and I would draw special attention to the fact that, although the valley narrows considerably towards the snout end of the glacier, and in consequence one would expect an increase in the flowing speed, the observations prove a decrease in speed to nearly one-third. Movement in cave from August 1 to September 18, or forty nine days, max. ·354 in., min. ·093 in., mean ·176 in. per day. (The surface movement taken at side of glacier, three-eighths of a mile from snout, up the valley, amounted to ·516 in. per day.) End of glacier receded in the same time 19 ft., or 4·65 in. per day. Ice advanced $8\frac{1}{4}$ in.; total loss in length 18 ft. $3\frac{3}{4}$ in., or nearly 4·5 in. per day. I must add that the point of observation was fixed at 40 ft. from the entrance, as beyond that and further in the cave the floor formed part of the glacier, and no fixed station could be found. Also, the surface friction of the ice on the shore—both at the side of the glacier, where the surface measurements were made, and at the cave—was considered about equal, and could therefore not account for the great difference of movement. HUGO LEUPOLD

November 10

Arctic Research

WITH reference to a letter in your number of this week (NATURE, vol. xxv. p. 53), in which it is stated that the Arctic shores trending north with a *western* aspect, are most encumbered with ice, and that those with an *eastern* aspect are most free from ice; I beg to suggest that, in order that your readers may not be misled on a point of geographical interest, you would do well to insert the following extract from the writings of Sir Edward Parry:—

"I will mention a circumstance which has particularly forced itself upon my notice in the course of our various attempts to penetrate through the ice in these regions; which is that the eastern coast of any portion of land, or what is the same thing, the western sides of seas or inlets, having a trending at all approaching to north and south, are, at a given season of the year, generally more encumbered with ice than the shores which have an opposite aspect. The four following may be adduced in illustration of this fact, and cannot but appear somewhat striking when considered in viewing a map which exhibits the relative position of the shores in question.

"It is well known that, in the extensive northern sea reaching from latitude 60° to 80°, bounded on the east by Lapland and Spitzbergen, and on the west by Greenland; the whole of the latter coast is blocked up by ice throughout the summer, so as to make it at least a matter of no easy enterprise to approach it, while the navigation of the eastern portion of that sea may be easily performed without difficulty, even to a very high latitude, and at an early part of the season. A second equally well-known instance occurs in the navigation of Davis Strait, which, from about Resolution Island, in latitude $61\frac{1}{2}$°, to the parallel of at least 70, is usually inaccessible as late as the month of August, and a great deal of it, in summer, is not accessible at all; while a broad and navigable channel is found open on the eastern side of the strait (that is, on the western coast of Greenland) many weeks before that time. We experienced a third and very striking example of this kind in coasting the eastern shore of Melville Peninsula in the years 1822 and 1823, the whole of that coast being so loaded with ice as to make the navigation extremely difficult and dangerous. Now, on the eastern side of Fox Channel, there is reason to believe, as well from the account of that navigation in 1631, and that of Baffin in 1615, as from our own observations, that there is little or no ice during the summer season. The last instance of the same kind which I shall mention is that of Prince Regent's Inlet, and of which the events of this voyage furnish too striking a proof, the ice appearing always to cling to the western shore in a very remarkable manner, while the opposite coast is comparatively free from it.

"These facts, when taken together, have long ago impressed me with the idea that there must exist in the Polar regions some general motion of the sea towards the west, causing the ice to set in that direction, when not impelled by contrary winds or local and occasional currents, until it butts against those shores which are actually found to be most encumbered by it."

I need only add that all subsequent observation has confirmed the accuracy of Sir Edward Parry's general rule; to which of course there are exceptions caused by the action of local currents and winds. CLEMENTS R. MARKHAM

21, Eccleston Square, November 19

Curious Formations of Ice

DURING a botanical expedition recently made to Gangotri Glacier I noticed, early on the morning of October 6, some very beautiful and curious formations of ice, which must have been formed during the previous night. It was freezing hard when I left my camp, after an early breakfast. The small pools beside the river were completely frozen over, and the smooth boulders of granite were coated with thick flakes of ice, which greatly increased the difficulty and danger of walking. Ascending a steep grassy slope (a favourite feeding-ground at this time of the year for barhal, or Himalayan sheep), I found the ground clothed over with small masses of pure white ice, very like mushrooms at a distance; I cannot give a better description of their general character than to liken them to a certain kind of thin, wafer-like cylindrical biscuit, which is sometimes eaten as an accompaniment of ices, only they were pure white and not cylindrical, but rather funnel-shaped, the larger opening being uppermost. In most cases there were two to four of these funnels, forming clusters round the lower portion of the stems of a species of Polygonum, which was abundant in this part of the valley, in an extremely dried-up condition. I should be glad to know if this curious kind of ice structure has been observed elsewhere.

Saharunpore, N.W.P., October 31 J. F. DUTHIE

Meteor

A MAGNIFICENT purple meteor was observed here on November 15, at 5h. 54m. p.m. G.M.T., by the Rev. A. Corti and one of the assistants of the Observatory. When first seen below β Aurigæ it was not very bright, but as it was passing through the constellation Lynx its brilliancy increased until it outshone Jupiter. Its shape was at first round, but, when it had passed near ϕ Ursæ, it burst into three pieces between γ and χ Ursæ, the largest of the three pieces being closely followed by the other two, which were as bright as first-magnitude stars. They all disappeared near η Ursæ, the total arc described being more than 70°. The meteor was visible for seven seconds, and left a long train, which soon disappeared. The velocity of the meteor decreased gradually as it approached its bursting point.

S. J. PERRY

Stonyhurst Observatory, Whalley, November 17

AT a quarter to five yesterday afternoon, when the sun had scarcely set and no star was visible, I and another inhabitant of this place saw a large blue meteor issue from a height of twenty degrees above the north-west horizon, and fall in a sharp curve for, say fifteen degrees, until it disappeared behind some woods. In falling it scattered large fragments behind it, but retained its nucleus, beside which Mars looked quite sickly. How vivid must the meteoric light have been! M. L. ROUSE

Sunnymead, Chislehurst Common, November 21

I OBSERVED a fine meteor last night at 1·3 a.m. It came into sight so closely in the neighbourhood of a brilliant white star, which I took to be Sirius, that, as it shot in an apparent straight line, or segment of a very large arc, across the sky, midway between Orion, then due south, and the horizon, the momentary illusion to the eye was that the star, which it equalled in magnitude and brilliancy had left its place and travelled west.

Bregner, Bournemouth, November 18 HENRY CECIL

ABOUT 5.45 on the evening of the 15th inst. a meteor, larger than Jupiter, but not so bright, appeared under Capella, and took a horizontal course, till it disappeared at about the same distance below the terminal star in the tail of Ursa Major. I never saw so long a flight. Twice in its course it disappeared or became very faint. Near the end it broke into two, the second part following the former. At any computation of its distance its flight in the upper regions of the atmosphere must have been in an enormously extended path. My son, who was with me, conjectured that its disappearance might be owing to its passing

through a deep trough, or hollow of a wave, in the surface of the atmospheric ocean; in which the diminution of the friction might occasion a loss of incandescence; a suggestion rather favoured by the repetition of the phenomenon. Perhaps the meteor was only making ducks and drakes.

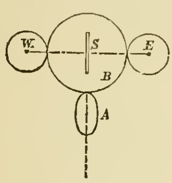
Rainhill, November 17 HENRY H. HIGGINS

Integrating Anemometer

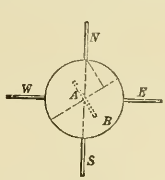
J'AI lu avec beaucoup d'intérêt la controverse suscitée dans les colonnes de votre estimable journal, à propos de "l'Anémomètre Intégrateur" présenté par M. Hele Shaw et le Dr. Wilson à la dernière réunion de "l'Association Britannique." Il arrive souvent, dans l'histoire des inventions, qu'une même idée, quoique diversement modifiée, vient presque simultanément à l'esprit de plusieurs individus travaillant dans des directions indépendentes, et il en résulte ainsi des questions de priorité difficiles à décider.

Ce n'est pas pour une question de ce genre que j'ose vous écrire aujourd'hui; mais l'idée de l'anémomètre intégrateur m'était venue aussi il y a quelques années, et la description de celui inventé par M. A. von Oettingen, que j'ai lu dans le "Repertorium" de M. Wild en juillet, 1878, me conduisit, si je n'ai pas mal compris, à la forme même de l'appareil de MM. Shaw et Wilson, et quelques jours plus tard à une autre, plus parfaite à mon avis, et que je n'ai pas encore eu l'occasion de mettre en pratique. C'est celle dont les organes les plus essentiels ont été représentés dans les figures ci-jointes.

Un disque (roller) vertical A peut, comme dans l'instrument de MM. Shaw et Wilson, prendre la même orientation que la girouette et au même temps tourner sur son axe horizontal avec une vîtesse proportionnelle à celle du vent. Sur ce disque s'appuit une sphère B, de poids et dimensions convenables, qui est aussi soutenu lateralement par quatre disques verticaux N., E., S., W., situés à angle droit entre eux. Le disque A fait mouvoir la sphère B dans le même plan vertical, et celle-ci les quatre disques lateraux; de sorte que, si les points de contact de ces disques avec la sphère ont lieu sur l'équateur dont le pôle est le point de contact du disque moteur, la vîtesse totale de celui-ci s'y trouvera decomposée dans les directions fondamentales N., S., E., W. Dès lors il suffira de munir chaque disque N., E.,



Projection verticale.



Projection horizontale.

S., W., ou bien deux disques quelconques adjacents, d'un compteur spécial, pour obtenir les composantes cardinales du vent.

Cet anémomètre intégrateur sera, comme ceux de MM. Shaw et Wilson et de M. Burton, plus simple que celui de M. von Oettingen, et en outre son action deviendra, pour ainsi dire, indéfinie, la transmission du mouvement s'y effectuant au moyen d'une sphère. Cette transmission se fait ici par *roulement sans glissement*, ce qui n'a pas lieu dans le système de M. von Oettingen, où cette circonstance constitue un grave défaut.

Pour ne pas prolonger trop cette lettre, je n'insisterai plus sur mon anémomètre, dont les indications peuvent être obtenues de diverses manières, et dont le mécanisme est susceptible de recevoir plusieurs applications.

Si vous croyez que les lignes précédentes contiennent quelqu'idée nouvelle et utile, je vous prie de vouloir bien les insérer dans votre estimable journal. En attendant je vous remercie d'avance, et veuillez aussi, Monsieur, agréer l'assurance de ma plus haute estimation. V. VENTOSA

Madrid, le 5 novembre

Geological Results of the Late Gales

THE late gales have had a very powerful effect in redistributing the beach-deposits along our coasts, and though many well-known geological sections have no doubt been covered up in consequence, many new ones have at the same time been brought to light. In this neighbourhood, for instance, at Whitley-by-the-Sea, near Tynemouth, a section of the highest interest to local geologists has been uncovered within the last few weeks, showing a well-marked uncomformity within the Coal-measures, which I, for one, although familiar with the place for years, was totally unaware of, and which, if ever observed before, has certainly never been recorded. For some time to come the section will probably remain exposed at low tides, as the sand which formerly concealed it has been entirely swept away. I will not weary your readers with a detailed description of the section, which will, in due time, be more appropriately published elsewhere, but merely beg to record the observation as an example of the kind of new matter that many geologists resident on or near our coasts will probably come across by searching along the cliff-bases just now. G. A. LEBOUR

November 15

The Recent Weather

AT 11 o'clock last night two thermometers outside stood at 66°·75. It was pitch dark, and blowing fresh from south-south-west. When last tested, these thermometers were not ·25 of a degree in error. Was such a temperature ever registered at such an hour on the 13th November before in Great Britain or Ireland? RICHARD M. BARRINGTON

Bray, Co. Wicklow, Ireland, November 14

Dipladenia amabilis

IF it is not already well known, it may interest some of your readers to hear that flowers of the *Dipladenia amabilis* last for a much longer time when placed in water if their tubes be also filled. Even when "too utterly weary" they can be revived in the manner I have mentioned. This may have reference to the fact that these flowers, unlike many creepers, generally turn upwards, and would therefore be likely to catch rainwater.

AMY MULHOLLAND

High Elms, Hayes, Kent, November 13

"The Lepidoptera of Ceylon"

WITH reference to the remarks of Dr. H. Trimen (vol. xxv. p. 32) to this work, now in course of publication under the patronage of the Ceylon Government, of which Parts I. and II. only had then reached him, and especially to the "protest" which he "feels bound to enter" against the name of the artist as there printed at the foot of the several plates, I may be allowed to state that the *original drawings* made by the native artist, Mr. W. de Alwis (representing about 350 species, or one-third only of the number of Ceylon Lepidoptera known to the author, and that will eventually be figured in this work), which Dr. Trimen states are in the Colombo Museum, were copied by his brother, Mr. George de Alwis, for Sir William H. Gregory, whilst Governor of the Island. These copies are in the author's hands, and it is from them, wherever a suitable figure is available, as well as from specimens of the actual species there represented, that the drawings, and afterwards the lithographing the figures on the stone, were made. The artist's name, as there printed on the several plates of the work, is consequently perfectly correct. In due course, Part IV.—completing vol. i. of this work—will reach Ceylon, wherein the preface is printed, and Dr. Trimen will there see that the native artist to whom he so specially refers, receives the necessary acknowledgment of his labours from the author. F. MOORE

Penge, S.E.

A GLIMPSE THROUGH THE CORRIDORS OF TIME [1]

I.

YOUR Committee has done me much honour by inviting me to deliver the first lecture in this large and very beautiful hall. In accepting the task I was aware that it involved a great responsibility, but I had various grounds of encouragement. I remembered that I was not coming among you as a stranger, and I knew that I had a subject worthy of a memorable occasion. I would I were

[1] Lecture delivered at the Midland Institute, Birmingham, on October 24, 1881, by Prof. Robert S. Ball, LL.D., F.R.S., Andrews Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland. Contributed by the Author.

equally confident of my ability to do justice to so noble a theme.

The lecture bears the somewhat poetic title of "A Glimpse through the Corridors of Time." A poetic title has been chosen, because if I can properly exhibit the subject you will see that it appeals powerfully to the imagination as well as to the reason. I shall invite you to use your imagination to aid in looking back into the very remotest recesses of antiquity. And when I speak of antiquity I do not mean the paltry centuries with which our historians have to deal. The ancient days to which I refer are vastly anterior to those of the "grand old masters" and those of the "bards sublime." Nor do we even allude to the thousands of years which have elapsed since Babylon and Nineveh were splendid and populous cities Even the noble pyramids of Egypt are but of yesterday when compared with the æons of years which must pass before our review.

The most ancient human monuments that now exist cannot, I suppose, be more than a few thousand years old. Five thousand years nearly exhausts all historical time. Ten thousand years certainly does. Though we have no earlier historical record, yet other records are not wanting. Geology tells us that ten thousand years is but a mere moment in the span of the earth's history. We learn from geology that even the career of man himself has lasted far more than ten thousand years. Yet man is but the latest addition to the succession of life on the earth. For the chronology of the earlier epochs of the earth's history we require majestic units to give adequate expression to our dates. Thousands of years are not sufficient, nor tens of thousands, nor hundreds of thousands. The course of geological time is to be reckoned in millions of years.

The corridors of time through which I wish to give you a glimpse are these dignified millions. Yet our retrospect will only extend to a certain definite epoch in the past history of our earth. We speak of nothing anterior to the time when our earth assumed the dignity of maternity, and brought forth its first and only child. We shall trace the development of that child which, though millions of years old, is still in dependence on its parent. We shall describe the influence of the parent over the child and the not less remarkable reaction of the child upon the parent. We shall foreshadow the destiny which still awaits the mother and child when millions of years shall have elapsed.

At the time of its birth the earth was not as we see it now, clothed with vegetation and teeming with animal life. It was a huge inorganic mass, too hot for life, perhaps hot enough to be soft or viscid, if not actually molten. The offspring was what might be expected from such a parent. It was also a rude inorganic mass. Time has wrought wondrous changes in both parent and child. Time has transformed the earth into an abode of organic life. It has transformed the earth's offspring into our silvery moon.

It will be my duty to sketch for you the manner in which these changes have been brought about. To a great extent we can do this with no hesitating steps, we are guided by a light which cannot deceive. It is the light of mathematical reasoning. These discoveries are of an astronomical character, but they have not been made by telescopes. They have been made by diligent labours of the most abstruse kind. The mathematical astronomer sits at his desk, and not in an observatory. He has in his hand a pen and not a telescope. Before him lies a sheet of paper and not the starry heavens. He is no doubt furnished with a few facts from observation. It is his province to interpret those facts, to inform them with life, and to infer the unknown from the known. It is thus discoveries are made which are the sublimest efforts of human genius.

The argument on which I invite you to follow me is founded on a very simple matter. Many of those present go every summer to the sea-side. Those who do so are well acquainted with the daily ebb and flow which we call the tides. Even the children with their spades and buckets know how the flowing tide will fill their moats dug in the sand and inundate their mimic castles. In the ebb and flow of the tide we have a mechanical engine of mighty power. I hope this evening to point out the wonderful effect which tides have had on the earth in times past, as well as the effect they will exercise in the future. It is the tides which are to reveal to us a glimpse through the Corridors of Time.

The cause of the ebb and flow of the tide has long ceased to be a mystery. In the earliest times it was noticed that the tides were connected with the moon. Pliny and Aristotle both refer to the alliance between the tides and the age of the moon. It is well known that the tides on our coasts sometimes rise to an unusual height. Those who dwell on low ground adjoining tidal rivers are painfully aware of this fact by the floods which are often produced. Such occurrences generally take place at the time of new moon or of full moon. At first quarter or last quarter the tides are even below the usual height. A fisherman who has to regulate his movements by the tides will know full well that at certain times the tides rise higher and fall lower than at other times. He brings his boat out on the falling tide, he brings it back on the rising tide, and when making the harbour after a night's fishing, it would be natural to hear him say "Oh, we shall run in easily this morning, there is a strong tide, the moon was full last night." Or if he had to cross a dangerous bank he would soon learn the difference between the spring tide and the neap. Fishermen are not much addicted to abstract reasoning. For many centuries, perhaps indeed for thousands of years, observant men might have known that the moon and the tides were connected. But they did not know any reason why this connection should exist. I daresay they did not even know whether the moon was the cause of the tides or the tides the cause of the moon.

Nor is it easy to explain the tides. We were all taught that the moon makes the tides. Yet I can imagine an objector to say, If the moon makes the tides, why does it give Bristol a splendid tide of 40 feet, while London is put off with only 18? The true answer is that the height of the tide is largely affected by local circumstances, by the outline of the coasts, by estuaries and channels. It is even affected to some extent by the wind. Into such details, however, I do not now enter: all I require is that you shall admit that the moon causes the tides, and that the tides cause currents. In some few places the currents caused by the tides are made to do useful work. A large reservoir is filled by the rising tide, and as the water enters it turns a water-wheel. On the ebbing tide the water flows out of the reservoir, and again gives motion to a water-wheel. There is here a source of power, but it is only in very exceptional circumstances that such a contrivance can be worked economically. Sir W. Thomson, in his address to Section A of the British Association at York, went into this question in its commercial aspect. At present, however, we may say that the power of the tides is as much wasted as is the power of Niagara. Perhaps when coal becomes more scarce, and when the means of distributing power by electricity are more developed, the tides and the great waterfalls will be utilised; but that day will not be reached while coal is only a few shillings a ton.

Though we have not yet put the tides into harness, yet tides are not idle. Work they will do, whether useful or not. In some places the tidal currents are scouring out river-channels; in others they are moving sandbanks. From a scientific point of view the work done by the tides is of unspeakable importance. To realise the importance, let us ask the question, Whence is this energy

derived with which the tides do their work? The answer seems a very obvious one. If the tides are caused by the moon, the energy they possess must also be derived from the moon. This looks plain enough, but unfortunately it is not true. Would it be true to assert that the finger of the rifleman which pulls the trigger supplies the energy with which the rifle bullet is animated? Of course it would not. The energy is derived from the explosion of the gunpowder, and the pulling of the trigger is merely the means by which that energy is liberated. In a somewhat similar manner the tidal wave produced by the moon is the means whereby a part of the energy stored in the earth is compelled to expend itself in work. I do not say this is an obvious result. Indeed it depends upon a refined dynamical theorem, which it would be impossible to enter into here.

But what do we mean by taking energy from the earth? Let me illustrate this by a comparison between the earth rotating on its axis and the fly-wheel of an engine. The fly-wheel is a sort of reservoir, into which the engine pours its power at each stroke of the piston. The various machines in the mill merely draw off the power from the store accumulated in the fly-wheel. The earth is like a gigantic fly-wheel detached from the engine, though still connected with the machines in the mill. In that mighty fly-wheel a stupendous quantity of energy is stored up, and a stupendous quantity of energy would be given out before that fly-wheel would come to rest. The earth's rotation is the reservoir from whence the tides draw the energy they require for doing work. Hence it is that though the tides are caused by the moon, yet whenever they require energy they draw on the supply ready to hand in the rotation of the earth.

The earth differs from the fly-wheel of the engine in a very important point. As the energy is withdrawn from the fly-wheel by the machines in the mill, so it is restored thereto by the power of the steam-engine, and the fly runs uniformly. But the earth is merely the fly-wheel without the engine. When the work done by the tides withdraws energy from the earth, that energy is never restored. It therefore follows that the energy of the earth's rotation must be decreasing, This leads to a consequence of the most wonderful importance. It tells us that the speed with which the earth rotates on its axis is diminishing. We can state the result in a manner which has the merits of simplicity and brevity.

"The tides are increasing the length of the day."

This statement is the text of the discourse which I am to give you this evening. From this simple fact the new and wondrous theory of tidal evolution is deduced. A great scientific theory is generally the outcome of many minds. To a certain extent this is true of the theory of tidal evolution. It was Prof. Helmholtz who first appealed to what tides had already done on the moon. It was Prof. Purser who took an important step in the analytical theory. It was Sir William Thomson's mathematical genius which laid the broad and deep foundations of the fabric. These are the pioneers in this splendid research. But they were only the pioneers. The great theory itself is chiefly the work of one man. You are all familiar with the name he bears. The discoverer of tidal evolution is Mr. G. H. Darwin, Fellow of Trinity College, Cambridge.

It would be impracticable for me now to go into the actual mathematical calculations. I shall rather endeavour to give you an outline of this theory, shorn of its technical symbols. I think this can be done even though we attempt to retain the accuracy of mathematical language. Nor would it be fair to throw on Mr. Darwin or the other mathematicians I have named the responsibility for all I am going to say. I must be myself responsible for the way in which those theories are set forth, as well as for some of the deductions made from them.

At present no doubt the effect of the tides in changing the length of the day is very small. A day now is not appreciably longer than a day a hundred years ago. Even in a thousand years the change in the length of the day is only a fraction of a second. But the importance arises from the fact that the change, slow though it is, lies always in one direction. The day is continually increasing. In millions of years the accumulated effect becomes not only appreciable but even of startling magnitude.

The change in the length of the day must involve a corresponding change in the motion of the moon. This is by no means obvious. It depends upon an elaborate mathematical theorem. I cannot attempt to prove this for you, but I think I can state the result so that it can be understood without the proof. If the moon acts on the earth and retards the rotation of the earth, so, conversely, does the earth react upon the moon. The earth is tormented by the moon, so it strives to drive away its persecutor. At present the moon revolves round the earth at a distance of about 240,000 miles. The reaction of the earth tends to increase that distance, and to force the moon to revolve in an orbit which is continually getting larger and larger.

Here then we have two remarkable consequences of the tides which are inseparably connected. Remember also that we are not enunciating any mere speculative doctrine. These results are the inevitable consequences of the tides. If the earth had no seas or oceans, no lakes or rivers; if it were an absolutely rigid solid throughout its entire mass; then these changes could not take place. The length of the day would never alter, and the distance of the moon would only fluctuate between narrow limits.

As thousands of years roll on, the length of the day increases second by second, and the distance of the moon increases mile by mile. These changes are never reversed. It is the old story of the perpetual dropping. As the perpetual dropping wears away the stone, so the perpetual action of the tides has sculptured out the earth and moon. Still the action of the tides continues. To-day is longer than yesterday; yesterday is longer than the day before. A million years ago the day probably contained some minutes less than our present day of twenty-four hours. Our retrospect does not halt here; we at once project our view back to an incredibly remote epoch which was a crisis in the history of our system.

Let me say at once that there is great uncertainty about the date of that crisis. It must have been at least 50,000,000 years ago. It may have been very much earlier. This crisis was the interesting occasion when the moon was born. I wish I could chronicle the event with perfect accuracy, but I cannot be sure of anything except that it was more than 50,000,000 years ago.

I do not admit that there is anything discreditable about this uncertainty. Do you not know that our historians, who have records and monuments to help them, are often in great confusion about dates? I am not going to find any fault with historians. They do their best to learn the truth; but I cannot help reminding you that they are often as much in the dark about centuries as the astronomers are about millions. Take, for example, the siege of Troy, which Homer has immortalised, and ask the historians to state the date of that event. Some say that the siege of Troy was 1184 B.C., others that it was 900 B.C.; both are equally uncertain. Schliemann says that he found the remains of the town burned down, but that no one knows who did it or when it was done. Others, again, say that there was never any siege of Troy at all.

A recent instance which has attracted great and deserved attention is Schliemann's discovery at Mycenæ of what he considers to have been the tomb of Agamemnon. The tomb certainly did contain the remains of some mighty man, if we may judge by the 100 lb. weight of

gold ornaments which were found there. Most people think that these tombs, whosever they were, date from at least 1000 B.C. On the other hand, some very high authorities regard the monuments as the tombs of northern invaders who came into Greece 500-600 A.D. Here then we have a range of some 1500 years for the date of the tombs, and no dates between these two are possible. I am sure I do not pretend to decide between them, or even to have an opinion on the subject; but I cannot help saying that in one respect the astronomers are better off than the historians. The historians cannot even agree whether Schliemann's gold ornaments are B.C. or A.D. Astronomers are, at all events, certain that the date of the moon's birth was before the present era.

At the critical epoch to which our retrospect extends, the length of the day was only a very few hours. I cannot tell you exactly how many hours. It seems, however, to have been more than two and less than four. If we call it three hours we shall not be far from the truth. Perhaps you may think that if we looked back to a still earlier epoch, the day would become still less and finally disappear altogether! This is however not the case. The day can never have been much less than three hours in the present order of things. Everybody knows that the earth is not a sphere, but that there is a protuberance at the equator, so that, as our school books tell us, the earth is shaped like an orange. It is well known that this protuberance is due to the rotation of the earth on its axis, by which the equatorial parts bulge out by centrifugal force. The quicker the earth rotates the greater is the protuberance. If, however, the rate of rotation exceeds a certain limit the equatorial portions of the earth could no longer cling together. The attraction which unites them would be overcome by centrifugal force, and a general break up would occur. It can be shown that the rotation of the earth when on the point of rupture corresponds to a length of the day somewhere about the critical value of three hours, which we have already adopted. It is therefore impossible for us to suppose a day much shorter than three hours. What occurred prior to this I do not here discuss.

Let us leave the earth for a few minutes, and examine the past history of the moon. We have seen the moon revolves around the earth in an ever-widening orbit, and consequently the moon must in ancient times have been nearer the earth than it is now. No doubt the change is slow. There is not much difference between the orbit of the moon a thousand years ago and the orbit in which the moon is now moving.

But when we rise to millions of years the difference becomes very appreciable. Thirty or forty millions of years ago the moon was much closer to the earth than it is at present; very possibly the moon was then only half its present distance. We must however look still earlier, to a certain epoch not less than fifty millions of years ago. At that epoch the moon must have been so close to the earth that the two bodies were almost touching. I daresay this striking result will come upon many with surprise when they hear it for the first time. It was, I know, with great surprise that I myself read of it not many months ago. But the evidence is unimpeachable, and it is indeed wonderful to see how such information has been gained by merely looking at the ripples of the tide.

Everybody knows that the moon revolves now around the earth in a period of twenty-seven days. The period depends upon the distance between the earth and the moon. The time and the distance are connected together by one of Kepler's celebrated laws, so that, as the distance shortens, so must the time of revolution shorten. In earlier times the month must have been shorter than our present month. Some millions of years ago the moon completed its journey in a week instead of taking twenty-eight days as at present. Looking back earlier still, we find the month has dwindled down to a day, then down to a few hours, until at that wondrous epoch when the moon was almost touching the earth, the moon spun round the earth once every three hours.

It would require the combined powers of a poet and a mathematician to pourtray the scene with becoming dignity. I have only promised to give you that glimpse along the Corridors of Time which I have myself been able to obtain. The scene is laid in the abyss of space; the time is more than 50,000,000 years ago; the *dramatis personæ* are the earth and the moon.

In those ancient times I see our earth to be a noble globe, as it is at present. Yet it is not partly covered with oceans and partly clothed with verdure. The primæval earth seems rather a fiery and half-molten mass, where no organic life can dwell. Instead of the atmosphere which we now have, I see a dense mass of vapours in which perhaps all the oceans of the earth are suspended as clouds. I see that the sun still rises and sets to give the succession of day and of night, but the day and the night together only amount to three hours instead of twenty-four. Almost touching the chaotic mass of the earth is another much smaller and equally chaotic body. Around the earth I see this small body rapidly rotating. The two revolve together as if they were bound by invisible bands. This smaller body is the moon. Such is the picture which I wish to present to you as a glimpse through the Corridors of Time.

I have hitherto refrained from introducing any merely speculative matters. If we can believe anything of mathematics, anything of dynamics, we must admit that the picture I have attempted to outline is a faithful portrait. The only uncertain elements are the date and the periodic time. I do however now propose to venture on one speculation in which Mr. Darwin has indulged. I propose to offer a suggestion as to how a small body came into this most remarkable position close by the earth, and how its motion was produced.

We have hitherto been guided by the unerring light of dynamics, but at this momentous epoch dynamics deserts us, and we have only probability to guide our faltering steps. One hint, however, dynamics does give. It reminds us that a rotation once in three hours is very close to the quickest rotation which the earth could have without falling to pieces. As the earth was thus predisposed to rupture, it is of extreme interest to observe that a cause tending to precipitate such a rupture was then ready to hand. It seems not unlikely that we are indebted to the sun as the occasion by which the moon was fractured off from the earth and assumed the dignity of an independent body. It must be remembered that the sun produces tides in the earth as well as the moon, but the solar tides are so small compared with the lunar tides, that we have hitherto been enabled to neglect them. There could however have been no lunar tides before the moon existed, and consequently in the early ages before the moon was detached the earth was disturbed by the solar tides, and by the solar tides alone.

The primæval earth thus rose and fell under the tidal action of the sun. Probably there were no oceans then on the earth; but tides do not require oceans, or even water, for their operation. The primitive tides were manifested as throbs in the actual body of the earth itself, which was then in a more or less fluid condition. Even at this moment bodily tides are disturbing the solid earth beneath our feet; but these tides are now so small as to be imperceptible when compared with the oceanic tides.

(*To be continued.*)

SOME "GUESSES AT TRUTH" OF THE EMPEROR KHANG-HI

KHANG-HI or Khang-hsi, one of the greatest of Chinese emperors, and indeed of Asiatic rulers, was born in 1653 and ascended the throne in 1661. For

sixty-one years he ruled his vast dominions with vigour and success. His biographers, the Jesuit missionaries, whom he treated with unusual consideration, represent him as a Chinese Admirable Crichton—man of letters, *savant*, philosopher, politician, philanthropist, and warrior. In his early years he showed the utmost ardour for study, and the love of learning continued with him until his death. When the Jesuits taught European astronomy he did not hesitate to place himself under them as a student. He has left-behind him works on most branches of human knowledge, extending over a hundred volumes. The fourth part contains his observations on natural history and physics. It was translated into French by Père Amiot, and partially published at Paris towards the end of the last century in the *Mémoires concernant les Chinois*, and is to be found in the fourth volume of that series. We here extract and summarise a few of the Imperial opinions. To use the words of the translator, "If our scholars find nothing to learn there, they will at least see that there is not so much ignorance amongst foreign nations as is generally believed." We follow the Emperor's language as far as possible.

Earthquakes.—Some years ago, when reading for instruction, as well as to foster my love of truth and reason, I had the curiosity to examine into the causes of earthquakes. One writer says that they come from air confined in the bowels of the earth, seeking to burst its prison and make an aperture for itself. An earthquake hardly ever extends more than ten leagues in area, although its effects may be felt over a hundred leagues. The manner in which a shock is felt on the surface depends on the nature of the ground through which it is transmitted. When the air [within the earth] is exhausted by a great shock there is no danger of another for some time; but a weak shock is almost always the prelude to another. In the dynastic history of Song it is stated that earthquakes are produced by the struggles of the *Yang*[1] against obstacles within the earth; while another work attributes them to the efforts made by the *Yang* and *Yin* to separate from each other. The countries north-west of China are very subject to earthquakes, ten years scarcely ever passing without one. The reason of this is that these districts contain vast sandy tracts where there is little rain, and the air within the earth is therefore keener and more vigorous. Earthquakes, on the other hand, which take place in countries adjoining the sea are less violent, for the earth is humid, and softens the air. People accustomed to the sea assert that there is no wind before an earthquake, and that at such times experienced pilots get as far off from the land as possible. This shows that the shocks are caused wholly by air.

Volcanoes.—An ancient writer states that a certain mountain in Yunnan was called the fire-mountain, because flames came from an opening in it. Some modern critics have accused this historian of lying; but volcanoes do certainly exist. They are mentioned in the records of the Song dynasty, and in other books. In the country of the Mongols flames are thrown up in many places. The fertility of the soil is much increased by these fires, for the people sow their grain near them, and reap a bountiful harvest in a few months.

Form of the Earth.—It seems evident from tradition and records that the North Pole has always remained in the same position. But what is the shape of the earth? Europeans, who are great travellers, say that it is round, and astronomy confirms this. One philosopher says that it is very old, and compares it to the yolk of an egg. How many things there are which we do not understand, but which will be known to future ages! We know the extent of our knowledge from ancient books, and so it will be with posterity from our books.

The Mariner's Compass.—The magnetic needle always declines a little. It cannot point directly to the south. This declination is uncertain, and does not depend always on the country. In the twenty-second year of my reign (1683) it declined three degrees at Peking, but only two and a half at present. The declination may be towards the east in one province, and towards the west in another. One of the Song letters says that this depends on the manner in which the needle is magnetised; but then why should the same needle vary in different years? Moreover, each compass should have its own declination, and there should be some which do not decline at all. Can it be that there is some accidental cause which is peculiar to each country? I believe Europeans say the needle turns towards the north; the ancients say that it is towards the south. Which is right? Neither party says why, and therefore no more is learned from one than from the other. However the ancients are the earliest recorders, and the more I see the more convinced I am that they understood the workings of nature.

[1] *Yang* and *Yin*, the dual powers which, united, Chinese philosophers regard as forming, directing, and modifying all things: the male and female principles.

Sound and Tones.—Nothing is apparently more simple than the theory of sound; but nothing is really more difficult or complicated. Sound conveys to the mind the developed ideas of others. The pleasure derived from music is half way between that felt at the art and the grosser voluptuousness of the senses. People possess ears without reflecting why, or what services they render and pleasures they procure. For myself, I have always been struck with the manner in which the tone of voice expresses the most varied emotions of the mind. It is not necessary to see the face, or even to hear the words spoken; the tone alone is sufficient to tell how the speaker is moved. It is with the voice as with beauty, the impressions made by it vary according to the person. There are people whose voices go straight to the heart, and are sufficient of themselves to inspire friendship or love. This fact, it is certain, is part of a theory of which we as yet know little. I have read many works on the theory of echoes. The ignorant account for them by fables, and the learned give rules I think the vibrations of two loud chords struck in unison should serve to explain the reason of echoes heard in valleys and from the walls of buildings.

The simpler the laws of nature and the more sublime, the farther they are from our comprehension; my own thoughts are most frequently those of doubt. I turn away from those who pretend to explain everything and wait for an explanation of the concord of the cords of the *king*[1] with the flute, the different sounds of a hundred instruments, and the numerous voices that find their way into the air, bearing to our ears an indefinable sense of harmony. Awaiting this I say to myself with the ancients, "That which is nearest us is most remote from our comprehension." My ignorance on these matters has never troubled me, because it is no obstacle to that great duty to flee the evil and do that which is good.

Climate.—The effect of climate on the inhabitants of a country as well as on its productions is very great. The men of the south are women compared with those of the north. Vigour of body imparts vigour of mind. When our court was in the south the increase of riches consequent on its sojourn there caused luxury, effeminacy, and a corruption of manners which almost changed the men into women, so enslaved and delicate did they become in this prosperity. Now that it is in the north, they have become firmer, more active, and more regular. Naturalists and astrologers are equally mistaken when they judge of the character, genius, inclinations, and customs of men according to climate and the stars. My Tartars are Tartars, as regards manner of life, as much in the southern provinces as in the north, and people from the south retain their habits when they come to the north. The history of each province exhibits *savants*, literary men, artists, warriors, and monsters alike. Man is man everywhere, and there is often as much difference between the people in one town as between those in provinces distant from each other. Leou-chi has truly said, "No climate tames the tiger, or gives courage to the rabbit."

Winds.—The proverb says that the wind which blows is the same a hundred leagues away, but the rain which falls is not the same ten leagues off. Why should this be? One can only reason on facts after knowing them, and I know that the statement respecting the wind is not always correct, for there have been different winds at the same time in the provinces of Pechili and Shantung, which adjoin each other. It seems to me that winds depend on the nature of a country. One writer says that they depend on the motions of the stars, and that therefore they never cease, although at one time they may be more violent than at another, according as they are more or less impelled towards the earth. Moreover, the change in the direction of the wind comes from the same cause. The air being confined between the earth and the higher spheres, escapes where it can; and possibly the difference between a high and a low wind may be explained in this way. Another ancient writer says that the quarter from which the winds come depends on the season, and that they pass directly from one cardinal point to another. All

[1] *King*, a sort of dulcimer made of glass or stone.

other winds are temporary and accidental. I have paid particular attention to this matter, and I find the usual wind in Peking is from the south-west, and that other winds do not continue for any length of time. From the *Y-king* it appears that was the same in the most ancient times. It is a fact, attested by the daily record of our observatory here, that the wind does not remain long in any of the four cardinal points, as asserted by the writer above mentioned. Whatever be the causes of the different directions of the wind, it is certain that there are local and temporary, as well as general and universal ones. These can only be discovered by a multitude of observations. Again, why is it that when the wind blows, ice melts first at the water's edge, unless it be that the wind has penetrated the water? A more singular fact still is that there are some winds which are only felt in deep water. The history of the Yuen dynasty affirms that people bathing have become icy cold from a wind of which they have become suddenly sensible.

Thermal Springs.—Nothing is truer than that mineral waters are very efficacious in curing several maladies. They are better for those past forty years of age than for younger persons. Hot baths enfeeble and exhaust the latter, because, the blood still possessing all its force, they cause fermentation and perspiration, which disorder and injure the constitution. At a more advanced age, on the other hand, they revivify the blood and clear the bones, nerves, and tissues of the body from the impurities which years bring in their train. Baths should not be taken for some time after eating, and one should be careful of exposure to the air after them. I mention this because everything affecting the health of mankind interests me. It is clear that the heat, smell, taste, and medicinal virtues of thermal springs are the effects of a mixture of foreign substances in the water. But what are these substances? In what quantity and proportion are they present? This has not been sufficiently examined. Whenever I meet a mineral spring on my journey I examine it by means of an alembic, and by the alum, sulphur, or metal found there I know its properties. In this respect we must not follow the ancients. They decided superficially by the taste, smell, or colour. I wish these waters were studied better, as then it would be known what diseases they were best suited to cure.

We have not space to give any more of the Emperor's observations. Those translated above are sufficient to show his love of knowledge, and his desire to benefit his subjects by utilising the results of research. Some of his remarks are almost epigrammatic, and with a few of them we will bring this article to a close.

"Lying is the first resource of ignorance; but what shall we do when we do not know the truth? Be silent."

"I love to admire the manner in which nature confounds our ideas of the greatness of human industry, and baffles all the resources of our penetration. How difficult it is to admire worthily! Is not a small insect, a blade of grass, more worthy of our admiration than any production of human hands?"

"We spoil children by our puerile cares for their health. We have, alas! too many wants; why should we increase them?"

"Heaven provides for the wants of men according to the places in which they live."

"I prefer to procure a new species of fruit or of grain for my subjects than to build a hundred porcelain towers."[1]

"Every one desires health and loves life, but no one practises temperance and frugality. They invent pleasant remedies which they imagine will cause them to digest. Eat little, and you will digest much."

"I attribute my good health to the fact that I drink nothing but water, which I distil myself."[2]

[1] For a description of the celebrated porcelain tower of Nanking, see Williams's "Middle Kingdom," vol. i. p. 82. It should be added that this remarkable work was destroyed during the occupation of the city by the Taipings, and it may be said of it now, *etiam pereunt ruinæ*.

[2] The absence of any system of drainage in Chinese cities should be remembered here.

ON THE EVOLUTION OF ANTLERS IN THE RUMINANTS

THE development of antlers in the Ruminants to which Sir John Lubbock alluded in his address to the British Association at York, confirms the truth of the doctrine of evolution in so clear a way that it is well worthy of being laid before the readers of NATURE, although I have already brought it in part before the Geological Society in 1877 (*Quart. Journ. Geol. Soc.* xxxiv. 419), and published it in outline three years later, in my work on "Early Man in Britain, and His Place in the Tertiary Period" The results of an inquiry to which I was led by a systematic study, extending over several years, of the more important collections of fossil mammalia in Britain, France, and Italy, may be summed up as follows:—

In the Middle Stage of the Meiocene the cervine antler consists merely of a simple forked crown (*Cervus dicroceros*), which increases in size in the Upper Meiocene, although it still remains small and erect, like that of the roe. In *Cervus Matheroni* it measures 11·4 inches, and throws off not more than four tynes, all small (Fig. 1).

The deer living in Auvergne in the succeeding or Pleiocene age present us with another stage in the history of antler development. There for the first time we see antlers of the axis and Rusa type larger and longer and more branching than any antlers were before, and possessing three or more well-developed tynes (Figs. 2, 3, 4, 5).

Deer of this type abounded in Pleiocene Europe, and I have examined their remains from the Red Crag of Norwich and of Suffolk, from various localities in Middle and Southern France, from Italy, and even from the little Island of Capri. They belong to the Oriental division of the Cervidæ, and their presence in Europe confirms the evidence of the flora brought forward by the Count de Saporta, that the Pleiocene climate of Middle Europe was warm. They have probably disappeared from Europe in consequence of the lowering of the temperature in the Pleistocene Age, while their descendants have found a congenial home in the warmer regions of Eastern Asia.

In the latest stage of the Pleiocene—the Upper Pleiocene of the Val d'Arno—the *Cervus dicranios* of Nesti (Fig. 6) presents us with antlers much smaller than those of the Irish elk, but so complicated as almost to defy description. This animal survived into the succeeding age, and is found in the pre-glacial forest bed of Norfolk, being described by Dr. Falconer under the name of Sedgwick's Deer (*C. Sedgwickii*).

The Irish elk, moose, stag, reindeer, and fallow deer appear in Europe in the Pleistocene age, all with highly complicated antlers in the adult, and the first possessing the largest antlers as yet known. Of these the Irish elk disappeared in the Prehistoric age after having lived in countless herds in Ireland, while the rest have lived on into our own times in Euro-Asia, and, with the exception of the last, also in North America.

From this survey it is obvious that the cervine antlers have increased in size and complexity from the Mid-Meiocene to the Pleiostocene age, and that their successive changes are analogous to those which are observed in the development of antlers in the living deer, which begin with a simple point and increase in number of tynes till their limit of growth be reached. In other words, the development of antlers indicated at successive and widely separated pages of the geological record is the same as that observed in the history of a single living species. It is also obvious that the progressive diminution of size and complexity in the antlers from the present time back into the early Tertiary age shows that we are approaching the zero of antler-development in the Mid-Meiocene age. I have been unable to meet with a trace of any antler-bearing ruminant in the Lower Meiocenes either of Europe or of the United States.

Nor are we left without direct evidence on this point. The discoveries in the Mid-Meiocene shale of Sansan in the South of France, published by Prof. Ed. Lartet in 1839 and 1851, and those made in New Mexico, Colorado, and Nebraska, and published by Prof. Cope in 1874–1877, present us with a series of antlers in which the burr is conspicuous by its absence. Still more

recently, in 1878, similar specimens (*Procervulus*) have been described by Prof. Gaudry ("Les Enchainements," p. 87) from the Mid-Meiocene strata of Thenay in the valley of the Loire. In all these cases the bony prolongation of the frontals—for antler it can hardly be termed—is small, erect, and variously branched, is persistent through life, and probably, as Prof. Cope suggests, was covered, as in the giraffe, and on young growing antlers, with skin.

In some, however, of Prof. Cope's specimens a well-marked burr is to be seen on some of the tynes (The United States Geogr. Survey, Part II. vol. iv. Palæontology, Pl. lxxx., 3*b*, 4*a*), due perhaps to an accidental stripping of the velvet, and consequent inflammation, resulting

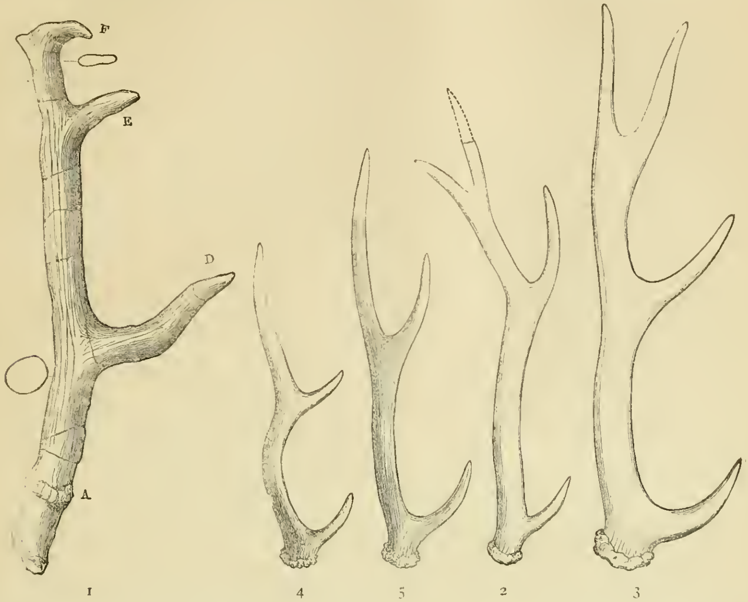


FIG. 1.—*Cervus Matheroni*, Gerv., Upper Meiocene, Mont Léberon ($\frac{1}{3}$) FIG. 2.—*C. perrieri*, Cr. and Job., Upper Pleiocene, Mont Perrier ($\frac{1}{5}$). FIG. 3.—*C. issiodorensis*, Cr. and Job., Upper Pleiocene, Mont Perrier ($\frac{1}{5}$). FIG. 4.—*C. etueriarum*, Cr. and Job., Upper Pleiocene, Mont Perrier ($\frac{1}{5}$). FIG. 5.—*C. pardinensis*, Cr. and Job., Upper Pleiocene, Mont Perrier ($\frac{1}{5}$).

in the death of the bony tissue above it. We may therefore conclude that this singular *Procervulus* type was the starting-point of the antlered Ruminants both in the Old and the New Worlds. In both, moreover, it is associated with the *Dicroceros* type. The two phases of antler development in the Mid-Meiocene age in Europe, and probably at the same age in North America, are represented by living deer, first by the transient condition of the

FIG. 6.—*C. dicranios*, Nesti, Val d' Arno ($\frac{1}{12}$).

young antler in the velvet, and secondly by the second antler in most species, and by the simple-forked upright antler of the adult muntjac.

The antlers also of the adult fallow deer (*C. dama*) present variations which can, in my opinion, only be accounted for by the doctrine of evolution. The ancestral form appears in the Pleistocene age in Britain, and is characterised by antlers palmated in front, instead of behind the beam, as in the normal living species, from which I defined it under the name of *C. Browni*, after its discoverer at Clacton in Essex. It occurs also in the gravels of the Thames Valley at Acton. Sir Victor Brooke has pointed out that some three or four specimens out of the vast number of antlers of the living form which he has examined possess

exactly the same character. Its appearance in the living form may be explained by the hypothesis of a reversion similar to that by which from time to time a horse is born with three toes, due to its descent from a three-toed ancestor. W. BOYD DAWKINS

THE GEOLOGICAL SURVEY OF ITALY

AMONGST the numerous signs of renewed life which characterise United Italy, the rapid spread of scientific research must take important rank. In its old homes at the world-famous universities, science, not often entirely neglected, is now once more largely cultivated. New Museums are springing up in many of the more important towns, and old ones are everywhere remodelled and enlarged.

Geology has its full share in this scientific revival, as a glance at the annual volumes of the *Geological Record* will show. The establishment of the Geological Society of Italy, to which we referred a fortnight back, will do much to encourage the study of this science.

The Geological Survey of Italy was established in the year 1868; since that date it has gradually developed, and has now accomplished some very important work. The Survey is at present a branch of the Corps of Mining Engineers, but we speak of the service in the phrase best known in England for similar organisations. Since 1870 twelve volumes of the *Bollettino del Ro. Comitato Geologico* have been published. These contain memoirs of various districts, often well illustrated, by members of the Survey or by other workers whose essays are considered to be worth publishing at the public expense. Probably many memoirs of the latter class will in future find their way into the Geological Society's volume, and the *Bollettino* be more purely official.

The organisation of the Survey is somewhat peculiar, and exhibits an amount of divided responsibility which can hardly conduce to its success. The service is partly under the control of a committee of eleven members and a secretary. Of this committee Prof. J. Meneghini of Pisa is president. Seven of the members are nominated by the King, chiefly from amongst the professors at the universities. These give their services gratuitously, only the actual travelling expenses being paid by the Government. The remainder are official members, and some of them are in other ways connected with the Survey.

Each member of the committee has a certain amount of influence in the control of the Survey within his own district; he is supposed to be consulted upon all questions relating to classification, naming of fossils, &c., but the surveyors are really responsible to the official chief of the Survey, M. G. Giordano. Three members of the Scientific Committee take the chief share in the direction. These are Prof. J Meneghini for Tuscany and Rome; Prof. G. Cemmellaro of Palermo for Sicily; and Prof. J. Capellini of Bologna, whose advice and assistance is always freely at the disposal of the Survey. This dual government might have been desirable in the early stages of the Survey; but now that Italian geology has made such progress, the staff so well trained, and the work so far advanced, it will probably be desirable to reorganise the Survey upon its own basis, giving the sole responsibility to its own official chief.

The surveying staff is part of the Corps of Inspectors of Mines (Ingegneri delle Miniere), the Chief Inspector of which is also the Chief of the Survey. Italy is divided into eight mineral districts—Turin, Milan, Vicenza, Florence, Ancona, Naples, Caltanissetta, Iglesias (Sardinia). The Inspectors of Mines have duties very similar to those of officers holding a like position in England. They visit and report upon mines in cases of accidents, and when any important changes take place in the working of the mines they may be called on for advice. The engineers are chosen from students trained in one of the seven engineering schools of Italy (Turin, Milan, Padua, Bologna, Pisa, Naples, Palermo). They then go for two years to a foreign mining school (Berlin, Freiberg, London, or Paris). Those engineers who are to serve on the Geological Survey Staff receive additional instruction for this purpose. Till now this extra training has generally been obtained from the Geological Survey of England, so that we may regard the Italian Survey as in a certain sense related to our own. Of the officers thus trained in England we may mention M. Anselmo, L. Baldacci, L. Mazzetti, R. Travaglia, De Ferrari, and E. Cortese; to the last named of these we are indebted for much information here given.

The basis of every geological survey must be a good topographical map. The Austrians published a map of a great part of Italy on the scale of 1 : 75,000; this however is not satisfactory. An entirely new topographical survey is now in progress; commenced in Sicily in 1862, it is gradually advancing to the north. The general map of Italy is on the scale of 1 : 50,000, with contour lines at every 10 metres. The more important mineral districts are published on the scale of 1 : 25,000, with contour lines at every 5 metres; a very beautiful map of Rome and the surrounding country is now published on the larger scale, as also are Sicily and parts of the N.W. Apennines. There is a smaller map, on the scale of 1 : 100,000, with contours at every 50 metres.

The small sum voted annually by the Italian Parliament has hitherto been spent in surveying only, and none of the maps have yet been published. They were however all exhibited at the Geological Congress at Bologna. It is expected that a larger grant will now be made, and the Survey be placed on a more satisfactory footing. The Central Survey office at Rome, hitherto lodged in the Piazza S. Pietro in Vincoli, will shortly be transferred to the handsome buildings lately erected for the Ministry of Agriculture, Industry, and Commerce.

The whole of the Island of Sicily has been geologically surveyed on the largest scale. This district is of commercial importance from its great yield of sulphur, amounting to 250,000 tons per year. The entire map of Sicily on the scale of 1 : 50,000 was exhibited at Bologna; this is a very beautiful work, and will be of great service to all students of that most interesting region. The Apennines north of Pisa are also surveyed on the scale of 1 : 25,000. This district is of great importance from the marble quarries of Carrara, Massa, &c., the yield of which is 150,000 tons per year. Great uncertainty has long been felt as to the geological age of the Carrara marble; it contains no fossils, and its exact relation to adjacent formations has hitherto been doubtful. It has at various times been referred to many different geological horizons; but now the geological surveyors seem definitely to have fixed its position in the Trias. The mineral districts of Sardinia and the Campagna of Rome have also been surveyed on the scale of 1 : 25,000.

The complete geological survey of a country is a work of some time, and many years must elapse before that of Italy is finished and its maps published. In the meantime the Survey has done a most useful work in preparing a general geological map of Italy on the scale of 1 : 500,000. For this purpose all previously published information has been utilised; the geological notices scattered through various scientific journals, Italian and foreign, have been collected and arranged by M. Giordano and his colleagues. The numerous blanks have been filled up by special researches; and the result is a valuable and beautiful map, which will shortly be published. It was desired to issue a reduction of this on the scale of 1 : 1,000,000, but as no topographical map on this scale exists, a French map was adopted, engraved on the scale of 1 : 1,111,111 (or 1 decim. to a degree). This map was corrected where necessary, and was published in time for the meeting of the Congress at Bologna. The map is issued in two

editions, one with hill-shading and one without. The only general map previously published was that of Collegno, in 1846, on the scale of 1 : 2,000,000. A glance at the two maps will show the immense advance which has been made in our knowledge of Italian geology since that date.

The map in question is coloured in accordance with the scheme recommended by the Italian Map Committee of the International Geological Congress. The Italian committee (like the English) prefer to retain some shades of red for the Trias. The Congress however, chiefly influenced by the wishes of Germany, proposes to colour this violet, as the natural base of the Secondary series; the Jurassic beds being coloured blue. The Italian Survey is desirous of adopting for its future maps the scheme of colouring upon which the Congress may decide. The Indian Survey also, being now about to publish a connected series of maps, wishes, if possible, to do the same.

We have little doubt that the geological map of Europe, now being prepared by the Map Committee of the Congress, will be so drawn up and coloured as to form a scheme of colours which can, with only small modifications, be adopted by all. W. TOPLEY

NOTES

A COMMITTEE has been formed at Reggio (Emilia) to collect funds for establishing a fitting monument to the memory of the Padre Secchi, in the form of a fine refractor, of which the objective is to have 70 centimetres diameter. Reggio thus follows the example of Arcetri, where a fitting scientific monument has been erected to the memory of Galileo.

THE Honorary Degree of LL.D. has been conferred by the University of Cambridge on Thomas Sterry Hunt, F.R.S.

M. COCHÉRY intends to spend the surplus of the Electrical Exhibition, which is said to exceed 16,000*l.*, in establishing a research laboratory for electricity.

M. PAUL BERT, the new French Minister for Public Instruction, is said to be a candidate, in the section of Medicine, to fill the place vacated in the Academy of Sciences by the recent death of Dr. Bouillaud.

IT is painful to have so often to animadvert on what must look like parsimonious treatment of science on the part of our Government. Its almost contemptuous treatment of the Electrical Exhibition and of the British Commissioners has called forth the strongest criticism; and under our Geographical Notes to-day will be found another instance of a similar kind. Lord Aberdare, who, as president of the Geographical Society, went to the recent Venice Congress as commissioner of that body, referred "to the miserable show made by this country at the Exhibition, which was solely due to the parsimony of the Treasury, who did not even pay the travelling expenses of the British Commissioners, and merely sent 100*l.* to the Vice-Consul at Venice for petty disbursement." Of course our Government had no intention of insulting the Congress and the Geographical Society; but such treatment of an International Congress on the subject in which this country is so practically interested, must seem strange to good-mannered foreigners. Our Government ought really to consider earnestly their position to such enterprises as those referred to; it is too late in the day for even England to despise anything that tends to the promotion of science.

A BRILLIANT *fête* was given at Berlin on the evening of November 19 in honour of Prof. Virchow, in the Hall of the Rathhaus, which was handsomely decorated for the occasion. About 1000 persons were present, chiefly belonging to the scientific and medical world. Prof. Bastian presided, and after calling for cheers for the Emperor, he presented the title deeds of the Virchow Institute for promoting anthropological studies, according to Prof. Virchow's own directions, and for which a sum of 70,000 marks has been collected from the various countries of Europe. Speeches were then made by the leaders of the thirty deputations present, which included representatives of the medical faculties of Aberdeen, Basle, and Charkoff, and the medical societies of St. Petersburg, Vilna, &c. Finally, a deputation from Schivelbein, in Pomerania, Prof. Virchow's native town, presented congratulations to the Professor, who returned thanks with great emotion. A supper followed, and the guests did not separate till a late hour.

THE death is announced, at the age of eighty-three years, of M. Camille Sébastien Nachet, the founder of the well-known firm of Nachet et Fils, opticians, Paris. M. Nachet, during his long career, did much for the improvement of the manufacture of lenses, and especially of microscopes.

WE regret to announce the death of Dr. Karl Peters, Professor of Mineralogy and Geology at Graz University, and author of numerous scientific papers, who died at Graz on the 7th inst., aged fifty-seven years. The death is also announced of Dr. Karl Fortlage, Professor of Philosophy at Jena University, at Jena on November 8, aged seventy-five.

THE Paris Municipal Commission has resolved to illuminate successively the Council Hall with five different electric lights, to determine the price of each, and make a choice amongst them. These five have been selected out of all the systems exhibited. The Swan and Brush systems are two of those selected for the competition. Electricity will be also used for moving an elevator of the kind exhibited by Mr. Muirhead, and a press for printing the papers used by the Council.

EARTHQUAKES have been rather prevalent on the Continent during the past week. Between five and six o'clock on the morning of the 16th three shocks were felt in Switzerland. Two were of some violence at Mendrisio, in the canton of Tessin, and one less severe in Berne and the Bernese Oberland. On the same morning, at seventeen minutes past five, a slight earthquake shock was felt at Naples, lasting three seconds. Its direction was south-east. At dawn a shock was felt at Cosenza. Two shocks were also felt throughout the province of Catanzaro at six o'clock in the morning. On the 18th at five a.m. several smart shocks were felt over the greater part of Eastern Switzerland. The centre of the disturbance seems to have been in the canton of Zürich and the Oberland of St. Gall, where the oscillations were very marked and frequently repeated. Shocks were also felt on the Friday night along the Valley of the Lower Rhine, at Coblentz, Bonn, Cologne, Aachen, Elberfeld, Barmen, Crefeld, Essen, Düsseldorf, and Duisburg, a distance of over 100 miles. There were two violent vertical shocks lasting five seconds, then wave-like tremors in the direction of north-west to south-east.

OUR Vienna Correspondent writes that shocks of earthquake occurred at Izentes and at Izarvas (Hungary) on October 28, at 4 a.m. On November 5 shocks were experienced at different places in Carinthia, viz. at Klagenfurth a perpendicular shock was felt at 9.37½ a.m.; it was followed by slight undulatory movements in the direction west-east, lasting four seconds. At Moosberg and Patermon several shocks were felt at 9.45 a.m.; direction, south-west to north-east. The shock was also felt at Villach at 9.40 a.m.; direction, south-north; at Ober-Vellach at 9.40 a.m., south-north. At Emünd four shocks occurred; the first, at 10.5 a.m., being so severe as to cause people to rush out of their houses in fright, chimneys were thrown down and the walls of some houses damaged; duration, four seconds; direction, north-south. At Spital (on the Drou) also four shocks were felt; duration, nine seconds; direction, from east-west. From Sachsenburg and Reichenan also the occurrence of shocks is reported at 9.30 a.m. at the former, and 9.45 a.m. at the latter place: the movements lasted

from four to five seconds; direction, north-east to south-west. The centre of the earthquake mentioned above seems to have been in the neighbourhood of the Millstädt Alp. At the same time earthquake-shocks were felt at Stuben, Langen, Pöhtnen, Flirsch in Vorarlberg, and at Murau and Obdach in Styria. In Switzerland shocks of earthquake occurred on November 14, at 3.35 a.m., at Villeneuve, Rivaz, Bouveret, and between five and six o'clock in the morning at Seewen, Berne and its environs.

A CORRESPONDENT of the Swiss *Bund*, writing from Vevey, says that on the morning of the 14th a large meteoric stone, which seemed to come from a point in the Hautler directly over the mountains on the Savoyard side of the Laste, fell with a tremendous report in the market-place of Vevey. It was sufficiently large to have crushed any house upon which it might have chanced to alight.

DR. T. S. COBBOLD exhibited (at the Linnean Society's meeting, November 5) under the microscope about a hundred eggs of *Bilharzia hæmatobia*. They were taken from a gentleman who had just arrived from Egypt, and who was the victim of hæmaturia, supposed to have been contracted during a shooting expedition. By adding water nearly all the eggs were hatched during the meeting of the Society, and a rare opportunity was thus afforded of witnessing the behaviour of the newly-born ciliated animalcules.

THE first step in the construction of a line of telegraph in China has been taken. On September 19 the line between Shanghai and Chinkiang on the Yang-tsze River was opened, and congratulatory telegrams exchanged between the authorities in the two places. The remainder of the line to Peking was expected to be completed within two months after that date. The cable, about two miles in length, was successfully laid across the Yang-tsze, and the line on the north of the river is now being rapidly pushed forward, following the line of the Grand Canal. Several other short cables will have to be laid across the larger creeks before the work is completed. With the exception of a line a few miles in length, between Woosung and Shanghai, which is the property of the Great Northern Telegraph Company, this is the first telegraph line laid in the Chinese Empire. When popular prejudice is once overcome, the extent to which telegraphs may be employed in China is incalculable.

IT is stated that the Chinese Government have taken measures for the immediate removal of the bar at the mouth of the Shanghai River, which has so long been a serious obstruction to navigation. At certain states of the tide ocean-going steamers are forced to remain in an exposed situation outside this bar, and all the efforts of the Foreign Ministers and mercantile communities to obtain its removal have been hitherto ineffectual. This is another example of the change which is coming over the Chinese counsels. *Apropos* of this we may mention that the ninth vessel constructed by the Chinese has just been launched at the Kiangnan Arsenal. It is a screw steamer of about four hundred tons, and is intended for the repression of smuggling and piracy. The vessels already built at the Arsenal are two frigates, four gunboats, a sailing ship, and an ironclad.

AMONG the numerous publications of the Imperial Maritime Customs of China, none are of more general interest than the half-yearly reports of the Customs medical officers. They deal, as might be expected, with various forms of disease among foreigners in China. The twenty-first number has recently been published. The writers are scattered all over the vast empire of China, from Newchwang in Manchuria to Canton, at various stations on the Yangtsze, and in Formosa. The latest issue contains papers on *Filaria sanguinis hominis* in Southern Formosa, on *Trichinia spiralis* in Chinese pork, and on skin diseases. This last is especially important, as one of the principal objections to Mongol immigration is the quantity of disease which follows. The Hawaiian Archipelago is said to suffer severely from diseases such as leprosy, small-pox, syphilis, measles, &c., which are all foreign to the islands, and have been introduced wholly by the immigrants. These papers certainly deserve more attention than they seem as yet to have received in this country.

THE disordered condition of the domestic affairs of Turkey has not prevented the Government finding leisure for the reform of its system of weights and measures. The new system which will replace the old clumsy method of computation will come into force on March 1 next, old style. It is strictly metrical, and applies to measures of length, square measure, and capacity. The measure of length will be based upon the archine, which is exactly equal to the French metre.

IN sinking for a stand-pipe for boring operations, the *Colonies and India* states, the Kilcunda (Victoria) coal prospecting party found the skeleton of a kangaroo at a depth of 28 feet. Instructions were given by the Mining Department to preserve the entire skeleton, and the jawbone was sent to Prof. M'Coy, who states that it belongs to a new species of an extinct genus of kangaroo, and indicates that the deposit which was found is of the pliocene tertiary age. The Professor says the discovery is a very interesting one, and will form a valuable addition to the public collection.

ON October 10 a fine fata morgana was observed at Rügenwalde (Pomerania). During the afternoon of that day a northern village with snow-covered roofs, from which icicles were hanging, was seen for about an hour. Human forms are also said to have been distinctly recognised. It is believed that Nexö, on the Island of Bornholm, was the village reflected.

AT the last meeting of the Linnean Society Mr. Frank Crisp was elected treasurer, and Sir John Kirk a member of the Council, to fill vacancies caused by the death of the late Mr. F. Currey.

THE great lava flow from the Mauna Loa (Hawaii), which lasted no less than nine months, has at last stopped. It began on November 5, 1880, and until August 31 last the lava had run a distance of 96 kilometres, from the summit of the volcano (which measures 14,000 feet in altitude) down the eastern slope, almost as far as the sea-coast. The town of Hilo was in the most threatening danger of being destroyed. Fortunately the force of the eruption was exhausted and the flow of lava stopped within a few thousand yards from the town. This eruption was the most colossal one ever recorded in Hawaii.

THE report of the Indian Commissioners shows the present number of Indians in the whole country, exclusive of Alaska, to be 261,912, all of whom, except 15,416, are more or less in charge of agents of the Government.

THE Conservatoire des Arts et Métiers of Paris has been removed from the Department of Trade and the Colonies and transferred to the Ministry of Fine Arts. The reason of this change is obviously the intention of developing technical education among French working men.

THE flashing system of telegraphy has been so successful in Tunis that the insurgent Arabs are powerless to stop regular correspondence between the several corps of the French army. The same system is used in Oran, province Algeria, in the pursuit of Bou Amena.

THE *Journal* of the North China branch of the Royal Asiatic Society for 1880 contains a long paper by Dr. Bretschneider, o the Russian Legation at Peking, on Early European Researches into the Flora and Fauna of China, and one by Dr. Bushell, of the British Legation, on the Coins of the Present Chinese Dynasty.

AN interesting cave has recently been discovered in the Bela Lime Alps, which form the north-eastern part of the Tatra Mountains. From the Kotlin valley the cave can be reached in about an hour. During August and September last the inhabitants of Bela thoroughly investigated the cave. The entrance is formed by a shaft about fifteen metres long and only one metre wide. After having passed this torches must be lighted. The cave contains fine white stalactites and stalagmites, large subterranean lakes and ponds, which obtained for it the name of "Seehöhle" (lake cave). A number of bones of prehistoric animals were found. It appears however that the cave was known to the neighbouring inhabitants about the years 1713 and 1731, and was then forgotten. German names with these figures underneath were in one part found scratched upon the rock.

ON September 1 an Aëronautical Society was founded at Berlin under the presidency of Dr. Wilhelm Angerstein. The new Society grows rapidly, and it is the intention of the Committee to hold an aëronautical exhibition next year.

THE additions to the Zoological Society's Gardens during the past week include a Moustache Monkey (*Cercopithecus cephus* ♂) from West Africa, presented by Mr. Frank G. S. Laye; a Bonnet Monkey (*Macacus radiatus* ♀) from India, presented by the Rev. R. H. Manley; two Herring Gulls (*Larus argentatus*), European, presented by Mrs. Greaves; two Chilian Sea Eagles (*Geranoœtus melanoleucus*) from South America, a Red-breasted Merganser (*Mergus serrator*), a Guillemot (*Uria troile*), a Bar-tailed Godwit (*Limosa lapponica*), British, purchased.

GEOGRAPHICAL NOTES

ON Monday week Lord Aberdare opened the fifty-second session of the Geographical Society with a brief address, in which he dealt first with the expedition of Dr. Matteucci and Lieut. Massari across Africa. He next referred to the geographical papers read at the York meeting of the British Association, and afterwards dwelt at some length on the International Geographical Congress at Venice. According to Lord Aberdare's view it is a great mistake to mix up exhibitions with these congresses, as, owing to international jealousies, it becomes necessary to withdraw the best men from the sections of the congress to serve on the juries of the exhibition. Lord Aberdare referred particularly to the miserable show made by this country in the Exhibition, which was solely due to the parsimony of the Treasury, who did not even pay the travelling expenses of the British Commissioners, and merely sent 100*l*. to the Vice-Consul at Venice for petty disbursements! The latter part of the address was chiefly devoted to the Arctic expeditions of the *Jeannette* and the *Eira*, and we are glad to notice that so much confidence is felt regarding the safety of Mr. Leigh Smith's party. Mr. F. A. A. Simons afterwards read a paper of considerable geographical interest on the Sierra Nevada de Santa Marta and its watershed, and he certainly has thrown much light on this almost unknown region, *i.e.* in the north-west corner of South America. The water-system, which Mr. Simons was at much pains to explain clearly, consists of the Rio Cesar, with its affluents, the Rio Rancheria and others falling into the Caribbean Sea, and the two large rivers which form the Grand Cierraga. Mr. Simons, who has spent some three and a half years in the country in natural history researches, has already contributed to the Geographical Society's *Proceedings* a paper on the topography of the Sierra Nevada, so that its geography can now be well understood through his labours.

SOME further details of the interesting discoveries made by the search ship *Rodgers* in and about Wrangel Land are given in the *Times*. It appears that the *Rodgers*, after leaving St. Lawrence Bay, passed through Behring Straits, and effected a landing on Herald Island on August 24. Having left records of her visit there, she steamed for Wrangel Land, which she reached on the evening of August 26. Finding a safe harbour, she despatched parties to the eastern and western coasts in search of cairns or traces of the *Jeannette*. Capt. Berry, who commanded the land party, reached a mountain 2500 feet high, from which he saw open water around the island everywhere, except between the west and south-south-west, where a high mountain seemed to terminate the land. Master H. S. Waring went round the eastern coast and northern side, and being blocked by ice had to return by land to the ship. Ensign Hunt went by the western coast and reached the ice which had blocked Waring, and found it impenetrable. He had passed to the northern side, and could see Waring's position, so that the entire island had thus been skirted. No traces of the *Jeannette* were found. The *New York Herald* correspondent says that he was "surprised to see the ice moving constantly to the westward along the shore, where, according to a natural supposition, the wind would blow it off. Sometimes when he went to bed he would see the pack ice filling the sea as far as the eye could reach, and the next morning when he went on deck he would behold a vast expanse of open water." Wrangel Land is now said to be about sixty miles long, and there is a current at the northern end of it running to the north-west, at the rate of about six knots an hour. At the south-east of the island the ice was observed to be drifting in a northerly direction, at the rate of about two miles a day. From all this it is inferred that the *Jeannette*, which was last seen in September, 1879, steaming towards Wrangel Land, did not reach that island, and that either she was caught in the pack, and is being carried by the current in a northerly direction, at about the 172nd meridian, or that, finding the sea open, as the *Rodgers* did, she has been induced to leave the land, and has taken advantage of open leads through the ice, and has sailed northwards into unknown space. Efforts are still being made to search for her or her crew if they have abandoned their ship. The *Rodgers* will winter at St. Lawrence Bay off Kotzebue Sound, on the Alaska coast, and will in the spring make further search. The American observation party have reached Point Barrow, where they will winter, and where they will have opportunity of searching among the wreckage, which is so often washed on that shore, for any records of the missing ship.

LIEUT. A. HOVGAARD, who was on Prof. Nordenskjöld's staff in the memorable *Vega* expedition, is trying to start an expedition in search of the *Jeannette*. Hovgaard thinks of sailing in the same track which was pursued by the *Vega*, in order to prove that the Kara Sea is perfectly navigable, if the necessary precautions are taken. He intends to winter at Cape Chelyuskin, in order to make scientific and principally meteorological observations. He has already received numerous contributions for this purpose from his Danish compatriots.

COUNT WALDBURG-ZEIL has safely returned from his Arctic expedition, which had for its object the establishment of a regular steamship service between Bremen and Siberia. His ship *Luise* encountered considerable difficulties; nevertheless the Count is of opinion that a regular service will be possible and remunerative. The *Dallmann*, the second ship of the Count's expedition, was left behind at the Yenisei estuary, where it will remain during the winter.

THE German paper *Ausland* publishes a letter from the German traveller Dr. B. Hagen, dated from Tandjong Morawa, to which he had returned from his excursion into the interior of Sumatra. He travelled through the Northern Batta districts, hitherto almost entirely unknown, and then across the plateau of Northern Tobah as far as the great Tobah Lake. The traveller was well received everywhere, and only the eternal wars between the several villages impeded and delayed his progress. His collections of anthropological, ethnographical, zoological, and particularly of botanical specimens are very large. The fauna and flora on the Tobah Plateau, as on all tropical high plateaux (such as Java, and even in Japan), resemble those of Europe.

NEWS from Zanzibar state that the Belgian expedition under Mr. Rogers left for the Congo on October 20 last, 135 natives accompanying it.

UNDER the Chefoo Convention, negotiated by Sir Thomas Wade with the Chinese authorities in 1876, it was agreed that a British officer could reside at Chung-king, in Sze-chuan, on the upper waters of the Yangtsze. The gentleman at present stationed there, Mr. E. H. Parker, of H. M.'s Consular Service in China, seems to have made good use of the opportunities thus afforded him of investigating this comparatively little-known district. Under the title of "Short Journeys in Sze-chuan," he has contributed to recent numbers of the *China Review* an account of his travels in the province, together with observations on its trade, customs, geography, &c.

THE PRESSURE ERRORS OF THE "CHALLENGER" THERMOMETERS[1]

I.

I. *The Pressure-Corrections supplied to the "Challenger" along with the Thermometers*

WHEN I was first asked to examine the thermometers I judged, from the appearance and nature of the protection over the bulbs, that very slight corrections only would be required, even for the greatest pressures to which they had been exposed. But Sir Wyville Thomson told me that a correction of at least half a degree Fahr. had been assigned for them for every mile under the sea. This correction had been given him by Capt. Davis of the Admiralty, who had in his experiments[2] the assistance and advice of such exceedingly able experimenters as the late Prof. W. Allen Miller and others.

Hence, although it appeared to me at first sight incredible that any such correction should be required for thermometers with protected bulbs, I considered it absolutely necessary to try Capt. Davis' experiments over again, under the same conditions as those which he had adopted in conjunction with Prof. Miller. My object was, of course, to find out whether I could again obtain these results, and, if I could obtain them, to discover what were the causes which led to their being so exceedingly different from what I should have expected. I felt assured that the results were much too large;—and I had therefore, if I could reproduce them, to trace the various possible causes of divergence between the results of experiments conducted in a hydrostatic press and of other similar experiments made at the same pressures in the deep sea.

Half-a-degree Fahrenheit per mile of depth may seem to be a matter of very little consequence; but when we recollect that some of the *Challenger* soundings were made at depths nearly approaching six miles, we find that we have sometimes to deal with a correction of 3° F., enough to modify seriously our theories of ocean circulation. For it can never be too strongly impressed on the student of science that there is no such thing as greatness or smallness in itself; what is very small relatively to one class of quantities may be very great relatively to another and different one. All the temperature differences, except near the surface of the sea, though important in their consequences, are very small relatively to differences of temperature in the atmosphere; but, just because they are so small, small errors in the determination of their values are important:—thus it was imperative to decide whether the corrections assigned by Capt. Davis are necessary.

At first sight one might think that by far the best way of conducting an inquiry of the kind would be to carry it out under circumstances nearly the same as those of the *Challenger* observations. No doubt, if we had at hand a coal-pit or mine-shaft full of water, and of six miles or so in depth, we might make the experiments without the aid of presses, and under circumstances far more favourable than those in which I was obliged to operate. The reasons for this statement will appear presently. There are great objections to making test-observations at sea. The *Challenger* observations themselves had, of course, to be made at sea, but to make under similar circumstances experiments for the purpose of determining corrections would be a perfectly hopeless attempt. The circumstances under which thermometers are let down and drawn up again at sea are extremely unfavourable to accuracy of observation. I had, therefore, to content myself with such conditions as could be procured by means of hydrostatic presses.

II. *Construction of the Thermometers.*—I will now say a word or two about the construction of the thermometers themselves; and I shall thus have an opportunity of pointing out some of the peculiarities of construction to which I have traced the greater part of the very large effects obtained by Capt. Davis, and given by him as corrections which required to be made.

The *Challenger* thermometers are all of the Six pattern: there is a highly expansible liquid in the large bulb, which projects to a certain extent into the narrow U-tube. Then there is a column of mercury occupying the bend of the U and part of each stem. Above that, on the maximum side, there is some more of the sensitive liquid; and at the ends of the mercury column are the maximum and minimum indices, each containing a piece of steel, so that they can be set by means of an external magnet. The large bulb on which the temperature effects are mainly produced is protected by an exterior shell of glass strong enough to resist a pressure of at least 5000 fathoms of sea-water; that is to say, approximately, somewhere about six tons weight per square inch. This external shell is nearly filled with alcohol. The main difference between this and the first invented form of protected thermometer, which (so far as I know) was introduced by Sir William Thomson,[1] is simply that the bulb only is protected, the stem being exposed, and therefore the effects produced directly by compression are due solely to the stem of the instrument; unless, indeed, there be a strain produced on the protected bulb (altering its volume) by the wry-neckedness of the protecting shell.

Now, as a rule, till quite recently, practical workers in glass supposed that no effect at all would be produced by pressure upon an ordinary thermometer stem, simply because the external diameter is so much greater than the internal; and, in fact, so little was the nature of the effects of hydrostatic pressure known to practical glass-blowers that one of Mr. Casella's workmen undertook in 1869 to furnish Capt. Davis with thermometers whose bulbs should be so thick as to "*defy compression*"! It will be seen presently that such an idea is entirely absurd:—that, however thick is an unprotected thermometer, it will still have its indications altered by compression, and very nearly as much as a thinner one, unless that be extremely thin. So far as the *Challenger* instruments are concerned, the only effect that can be expected to be produced directly by pressure is the diminution of the bore and length of the narrow tube, and the consequent forcing of the liquid which occupies it to fill a greater length in it. I made at starting a rough calculation of the amount of effect of this kind which was to be expected; taking average data as to the compressibility and rigidity of glass. I found it to be a small fraction only of a degree for each ton-weight of pressure, except on those thermometers which had very short degrees. It was clear to me, therefore, that (unless the wry-neckedness already mentioned was the cause) the larger part of Capt. Davis' result was not due to pressure directly.

III. *Wholly Protected Instruments. Their Defect.*—For the purpose of comparison with the *Challenger* instruments, so far as regards the effect on the unprotected stem, Sir Wyville Thomson sent me two mercury thermometers constructed after Sir William Thomson's device. In these instruments the whole, bulb and stem alike, is inclosed in a strong glass tube, nearly filled with alcohol. The effects of pressure on these instruments were very much smaller than on the thermometers of the *Challenger*. This result was so unexpected that I at first thought it due to defects in the new instruments. But, as will be seen later, it is quite consistent with the final result of my investigations. It is, however, very difficult to obtain good results from these instruments under the circumstances in which I was working. Their recording adjustment is constructed on a new plan, in which a little portion of mercury is detached from the rest; and separated from it by a small quantity of air, which does not move it until compressed to a definite amount. To set the index before an observation, the instrument has to be swung round somewhat sharply at arm's length. It was scarcely ever possible under these circumstances to adjust it to the temperature of the water in the press. The indices in the *Challenger* thermometers, on the other hand, consist each of a piece of enamel with a couple of hairs attached to it so as to fix itself in the tube and retain a record of the observation. They have also a little piece of needle inside, and can thus be moved from the exterior by means of a horse-shoe magnet, so that the adjustment can be made at pleasure, and without any alteration of the temperature. The thermometers are plunged for some hours in the water in the press, and the indices are set in an instant while the instrument is partially lifted out for the purpose. With the other instruments one might spend days before he could get them

[1] By Prof. Tait. Abridged by the Author from a forthcoming volume of the Reports of the Voyage of H.M.S. *Challenger*, by permission of the Lords Commissioners of H.M. Treasury.

[2] "On Deep-Sea Thermometers," by Capt. J. E. Davis, R.N. (*Proceedings* of the Meteorological Society, April 1871).

[1] "The Effect of Pressure in Lowering the Freezing-point of Water experimentally demonstrated," by Prof. W. Thomson (*Proc. R.S.E.*, February 1850). See also the paper by Parrot (1833) quoted below. In this a protected thermometer was undoubtedly employed; but the protecting sheath was part of the wall of the compression apparatus and was not attached to the thermometer itself. From a reference in this paper I was led to consult Lenz' observations on deep-sea temperatures. He appears to have measured these temperatures by bringing to the surface, with great care, a considerable quantity of water from each depth. There was a thermometer in the collecting apparatus, with a bulb of extra thickness; but no recording index was employed, so as to show what was its indication under pressure.

introduced, except after special cooling, into the press with the index suitably adjusted to the temperature of the water. The whole difficulty might have been avoided by putting an exceedingly small piece of iron or steel wire above the index, to be acted on by a sufficiently powerful magnet.

Thus, although these instruments are absolutely perfect so far as regards immunity from pressure (and in other essential respects which will be mentioned later), it is not easy to work with them under the circumstances of this investigation.

IV. *Individual Peculiarities of some of the "Challenger" Thermometers.*—The *Challenger* thermometers are not all exactly similar to one another. Some of them have their degrees very much longer than others; others have the extraordinary peculiarity that the degrees upon the maximum side are nearly half as long again as those on the minimum side, and sometimes it is the reverse. In one of the instruments which was occasionally used in the deep sea, the length of a single degree on the maximum side is only about three-fourths of a millimetre, and thus a reading to a tenth of a degree is not to be looked for. But on account of this unexpected peculiarity this particular instrument was of use, as will be seen later, in demonstrating that the effects produced in the press were due partly to heating, partly to compression. Several instances of useful peculiarities of a similar character were detected, and utilised.

In fact, the instruments cannot be said to do more than furnish rough and ready means of approximating to temperatures within about a quarter of a degree, or in the most favourable circumstances a tenth of a degree Fahrenheit. Had they been more nearly what would be called "scientific" instruments, they might have altogether failed on account of the rough treatment to which they were necessarily subjected during use. Letting them down into the sea presents in general no great difficulties, but when they have to be hauled on board again they are subject to jerks and shocks, and sometimes swing through large arcs at the end of the lead line. Such misadventures are unavoidable at sea, and are excessively unfavourable to accurate results, because the index is necessarily not fitted so tightly in the stem that it may not in a few oscillations be sensibly displaced. And there is a defect inseparable from the use of movable indices:—viz. that the reading of the mercury column is sensibly different according as the index is, and is not, in contact with it. The capillary convexity affects the maximum and minimum indices in *opposite* ways.

Further, I may observe (though it does not affect my work) that in these thermometers the scale is at some distance from the mercury in the stem, and no provision is made for avoiding parallax or personal equation. By merely altering the position in which one holds the thermometer, it is possible to read the temperature whether by the mercury column or the end of the index next it, to an amount different in some of the thermometers by as much as a quarter of a degree, and in the great majority of them by as much as a tenth. Thus if we get readings consistent within a tenth of a degree we get all that the instruments are capable of furnishing. I have therefore always read the thermometers in exactly the same position and (when so much accuracy was attainable) only to the nearest tenth of a degree. And I have always made my comparisons between successive positions of the index; the only readings of the mercury directly being taken roughly to find whether any permanent temperature-change had been produced in the water of the press by pressure or otherwise, during the course of an experiment.

A great many different materials were tried for the framing of the thermometers: and vulcanite was finally chosen, having been found to answer the purpose exceedingly well. Wood warped, and metal was unsuitable for various reasons. It is rather curious to find, as will be seen below, that this substance was one of the main causes of the very large amount assigned to the pressure-correction.

V. *Capt. Davis' Mode of Testing; and his Correction for the Maximum Side.*—It is necessary to look somewhat closely into the mode in which Capt. Davis conducted his experiments, in so far at least as it differs from the one I afterwards employed; in order that we may be able to form an idea how, with nearly all the facts before him, he yet failed to get their proper interpretation. Take, for instance, the way in which he attempted to determine the correction which is due to the heating of water by compression. This, of course, affects the thermometers while in the hydrostatic press, but *not* when they are let down into the sea. When the water in the press is compressed with the thermometers in it, it becomes hotter as the pressure increases (so long at least as its temperature is above 4° C. or 39°·2 Fahr. that of its maximum density). This is quite analogous to the heating of air in a cylinder when a piston is suddenly forced down; when, as every one knows, tinder can be kindled by the heat developed. So water is heated by compression, but not to anything like the same extent. But it is necessary to remark that the amount of heating of water by a given compression depends in a very curious manner upon the original temperature of the water. For water taken at its maximum density is neither heated nor cooled by compression, but it is heated by compression if it is at a temperature higher, and cooled if it is at a temperature lower, than that of the maximum density. One set of Capt. Davis' observations were made in water at temperatures near, but under, the maximum density point: in which, therefore, very little effect can be produced, even by very great pressure (and that little should be cooling, not heating), and he combined these with a number of other observations made at temperatures approaching 55° F., in which a comparatively large amount of heating is produced even by moderate pressures. The average of the results of these determinations was taken, but, unfortunately, Capt. Davis struck out before taking the average all those observations which appeared to give much larger effects than the others, taking them as being obviously erroneous.

When we sift out from the observations all those made nearly at any one temperature we find they agree fairly enough with the theoretical result of the compression. But observations made at different temperatures were included in the group from which the average effect was deduced. Such an average has no physical meaning.

Capt. Davis concluded from two sets of observations, one at 55° F. and the other about 39° F., that little attention need be paid to the heating of water by compression, and thus that the effect observed in the hydraulic press was due mainly to direct pressure, and would, of course, be experienced by the thermometers when they were let down into the sea.

The officers who managed the thermometers of the expedition, were, in consequence, furnished with corrections for each thermometer, all of the order already indicated, *i.e.* about half a degree for each mile under the surface of the sea. These corrections were, of course, for the *maximum* side of each instrument.

VI. *Consequent Correction for the Minimum Side.*—Looking at the thermometers, it seemed to me perfectly evident that this correction, if it was to be applied at all, must be applied in very nearly the same amount both to the maximum index, for which it was determined, and also to the minimum. Any difference between these two must be due solely to the effects of temperature upon the column of mercury which lies between the two indices, and of pressure on the tube containing that mercury. Unless the heating effect were *confined* to the space between the indices, the former is provided for by the graduation of the instrument itself; and it was quite certain that the two together could not produce an effect amounting to more than a small fraction of the degree and a half for three tons pressure.

Therefore, as all the readings of the *Challenger* thermometers were taken from the minimum index, they were subject, according to my interpretation of Capt. Davis' results, to a correction of very nearly half a degree Fahr. for every mile of depth.

Now, even if the heating effect on the water in the press had been correctly determined, the result would have led to a deduction of at the utmost only about one-fourth of the whole correction, thus still leaving a very formidable correction indeed.

VII. *Theoretical Determination of the Direct Effect of Pressure. Experimental Verification.*—I therefore calculated the effect of pressure on a thermometer tube, assuming the best data for the compressibility and the rigidity of glass. The result, so far as is required for the present argument, is that the internal capacity of a glass tube (whose walls are thick in comparison with the diameter of the bore) is reduced by about 1-1000th part for each ton weight (per square inch) of pressure applied from without; the ends being closed. Hence, if such a tube be partly filled with mercury, with an index above it; the index should be displaced by 1-1000th of the length of the column of mercury for each ton weight of pressure applied to the outside of the tube.

I tried the experiment with a thermometer tube, the length of the mercury column being as nearly as possible a metre, and I found for every ton-weight of pressure to which the tube was exposed the index was displaced by one millimetre, the 1-1000th part of the length of the column precisely, being far more nearly than I had expected the result I had already calculated from

theory. Since, then, there is only a change of one-thousandth in the length of the column, it is quite obvious that the amount of effect produced upon the column of mercury in the *Challenger* thermometers (which is not above a sixth or a seventh of a metre in length at the utmost), that is to say, the whole correction-difference between the maximum and minimum indices is a matter of a sixth or seventh of a millimetre; or in general very nearly the same fraction of a degree of the scale. Thus it is proved that the correction supplied by the Admiralty, if it is to be applied at all, ought to be applied almost in its entirety to the minimum index.

VIII. *The Aneurisms. Their Object and Effects.*—There is another peculiarity of the *Challenger* thermometers, which leads to a slight—but only a slight—modification of this statement, viz. that at the lower end of each of the two vertical columns there is an aneurism on the tube These form a sort of secondary bulb, making the tube faulty again after the primary bulb has been protected Their effect is slightly to increase the effective length of the column of mercury.

I learned from Sir George Nares that the object of these aneurisms, and of another which is situated close to the bulb, is to prevent the indices from being jammed at the bends of the stem, or forced into the bulb, when the instrument is expoed to very high or very low temperatures. They seem to be in every respect objectionable, especially as the necessity for them would be entirely removed by adding an inch or two to the length of the instrument; or, if they must be retained, by *protecting* them and using more powerful magnets. Their presence produces an effect large compared with their apparent importance. The sketch below represents, on a large scale, one of the most highly developed of the more effective of these aneurisms, that which is situated close to the main bulb of the instrument.

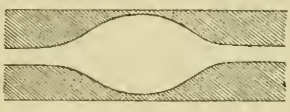


FIG. 1.—The chief Aneurism.

By reason of the convexity of the thermometer tube the diameter of the bore appears from the outside to be considerably larger than it really is. In fact a very simple geometrical construction shows that the ratio of its apparent diameter to its real diameter is that of the refractive index of glass to unity, *i.e.* it appears to be about 1·6 times its actual diameter. So that even when the aneurism, and the liquid filling it, appear to occupy the whole diameter of the tube, they only occupy $\frac{1}{1\cdot6}$ or about two-thirds, so that even in this extreme case the walls of the aneurism are not usually very thin. The percentage diminution of volume of the middle portion of the aneurism is in such a case (roughly) 50 per cent. greater than that of the unaltered tube.

The real mischief done by the aneurism is not due mainly to thinness of the walls and consequent greater liability to distortion by pressure; it is due to the fact that the aneurism, in consequence of its greater section, contains a much larger quantity of mercury than does an equal length of the tube; and therefore that a small percentage diminution of its volume will produce a marked displacement by the outflow into the narrow tube. Several of the aneurisms I have measured produce a disturbance of the index corresponding to that produced by at least five times their own length of the tube.

In some of the more exaggerated ones it actually produces an effect on the maximum and minimum index equal to that due to the extension of very nearly one-half of the mercury column in the thermometer. But this, though easily remediable, is not a defect of much consequence.

IX. *Imploding and Exploding of the Thermometer Bulbs.*—In connection with the breaking of some of the thermometers, as a result of pressure whether in the press or in the sea, it may be well to describe the curious nature of the effects produced by pressure upon the material of a tube, according as the pressure is applied from without or from within.

First, with regard to the thermometers themselves, which are exposed to external pressure, but have comparatively very slight pressure applied in the interior of their bore; and second, the corresponding effect when pressure is applied, as in the press itself, from the inside and tends to stretch the walls. [This second case has occurred with one or two of the *Challenger* thermometers also. Its source is usually defective strength of the terminal bulb of the maximum end of the tube. This bulb implodes, then the pressure is applied to the *interior* of the protected bulb, which, in its turn, explodes.]

In the diagrams below, the first three figures refer to part of the walls of the glass tube, which is exposed to pressure from the outside, but has no corresponding pressure applied within.

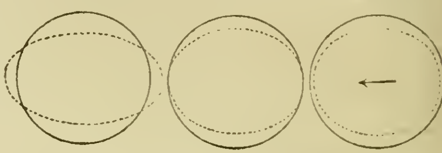


FIG. 2.—Distortion due to external pressure.

The effects of pressure indicated are those in a transverse section of the tube. The circles represent (on a large scale) transverse sections of very small spherical elements of the glass wall of the tube, the first close to the outside, the second in the middle of the wall of the tube, and the third close to the inner surface. The ellipses which are drawn along with the circles represent (of course, with much exaggeration) the corresponding transverse sections of the ellipsoids into which the spheres are distorted by the external pressure. The sphere near the outside is compressed in all directions, but much less in a radial direction than it is in a direction perpendicular to the former. The greatest amount of compression is tangential as it were, and the circular section of the sphere has been compressed into an ellipse which has a major axis in the radial direction very nearly equal to its original length, while the minor axis is very considerably reduced. The second figure refers to a small spherical portion inside the glass wall originally situated at a distance from the axis equal to 1·6 times the internal radius of the tube. (It is curious that the number 1·6, though obtained from a totally different source, should be so nearly the same as that already quoted as the refractive index of the glass.) The little spherical element at that place suffers no radial compression, but there is considerable tangential compression. Close to the interior surface of the glass tube we find large compression in a tangential direction and actual extension in the radial direction. These diagrams have been purposely exaggerated to make the effects visible. They represent what would be the effect of a pressure of 650 tons weight per square inch, provided glass could stand such a pressure and still continued to follow Hooke's law; and the outer radius of the tube has been taken as 2·2 times the inner. But they give all that is really required, viz. the *character* of the distortion at different points in the wall of the tube.

The next three figures represent the corresponding changes in

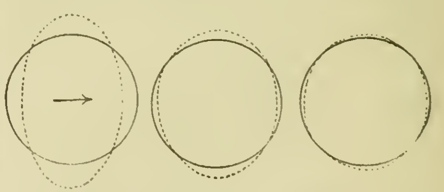


FIG. 3.—Distortion due to internal pressure.

spherical elements of the same cylindrical tube exposed to pressure from within. All portions of the tube are now extended tangentially and compressed radially, but the amount is greater on each layer as it is nearer the interior surface.

It is now easy to see how it is that a glass tube is broken by the application of pressure from without. The effect is, of course, produced first at the interior surface. For the compression is the same for every portion of the glass, but it is accompanied by shear, which increases towards the inner surface; and it is

probably the resulting extension which produces the effect. But when a tube is exposed to pressure from the interior there is dilatation of the walls, which aids the shear. Thus we see why a thin tube is so much more capable of resisting external than internal pressure. It is probable that, in the case of glass, the element which first gives way is not so much crushed as torn asunder. If so, the tube which is compressed from without is in a much more favourable condition for resisting than that in which the pressure is applied internally. For, in the first, the whole substance of the walls is compressed, and thus the linear extension produced by the shear is in part counteracted. In the second, the whole substance is expanded, and the linear extension due to the shear is aided. As will be seen in Appendix A, the case of very thick tubes is considerably different.

X. *Description of the Apparatus for applying Pressure.*—Sir Wyville Thomson handed over to me, with the thermometers, a press which was made for him before he started in the *Challenger*, and which he had carried all round the world; but when we made some preliminary experiments with it, we found it to be objectionable in many ways. It was in the first place not safe at high pressures, although an attempt had been made to strengthen it by surrounding it with massive rings of Swedish iron. As the experiments had to be conducted in college, and to a great extent by students who volunteered their services, this was a fatal defect; though I believe that the danger from the bursting of a hydrostatic press has been usually very much exaggerated. The bursting of the cylinder itself would probably be unattended with danger; but some of the nuts and connecting pieces had occasionally been projected with great violence.

A slight numerical calculation shows that a cubic foot of water at a pressure of one ton weight to the square inch is capable of doing only about 1210 foot lbs. of work in expanding, the reason being that although the pressure is intense, the amount of compression it produces is exceedingly small. But a cubic foot of air at a pressure of a ton weight to the square inch is capable of doing nearly 1300 times as much work in expanding. Hence the danger of having large quantities of air in the press before the compression is begun.

Another defect of the apparatus was the comparatively small interior bore, which did not admit of the proper carrying out of my scheme for measuring pressures—the Bourdon gauge having shown itself quite untrustworthy. Besides, two thermometers, at most, could be exposed to pressure simultaneously, even when no gauge was inserted along with them.

The apparatus which Sir Wyville Thomson finally obtained from the Woolwich gun factories, through the intervention of the Admiralty, was in fact a Fraser gun with a few adaptations made to suit it to the purposes of the investigation. The gun was made of a cylinder of mild steel, round which were shrunk two successive wrought-iron coils. The effective interior is 4½ inches in bore, and nearly 4 feet long.

This cylinder was guaranteed to be safe under pressures up to 18 or 20 tons weight per square inch, and we have for various purposes already worked up to pressures of 11 and 12 tons.

The rest of the apparatus, to fit it for our immediate purpose, consisted of a tightly-fitting steel plug which was forced into the upper end of the cylinder after the thermometers and other apparatus had been inserted, and the whole had been filled with water. The plug was forced down by the weight of an assistant standing on it, while a stop-cock at the bottom of the cylinder was kept open for the escape of water, until a massive steel key could be put in through a slot in the side of the cylinder to lock the plug in its definite position.

To the lower end of the steel cylinder were adapted a series of fittings by means of which it could be connected with a powerful force-pump, and simultaneously with a gauge whose construction will be afterwards described. The gauge enabled the experimenters to know at every stage of the operation what amount of pressure had been reached in the interior of the cylinder. The pump was worked at first by hand. Of late a more powerful pump has been procured, and it can be fitted when necessary to the gas-engine of my laboratory.

Only one real difficulty was met with in working this apparatus; viz. the difficulty of making the plug fit perfectly tight. At first, when it came from Woolwich, the plug was finished by a piece of leather in the form of a cup; but this was found to leak seriously even at very moderate pressures, so that even the comparatively small pressure of a ton weight per square inch was unattainable.

But by taking off the leather from the plug and furnishing it with a ring of steel turned into cup form with an exceedingly thin and sharp edge, on the same principle as that on which the piston of the pump was constructed, this difficulty was completely got over. The flexible steel edge was pressed against the interior of the tube more forcibly the greater the applied pressure, and it was found that the apparatus was then, except under the most unfavourable circumstances, perfectly tight, at least so far as the plug was concerned. Very great care was, however, requisite in cleaning the plug and the upper part of the bore of the cylinder before each experiment. The smallest fragment of cotton-waste, getting behind the edge of the cup, almost invariably produced serious leakage when high pressure was applied. The cup form was objectionable for one reason, that it always took down a considerable quantity of air, of which it was impossible to get rid. This difficulty was overcome by putting into the cup a quantity of tallow which completely filled it up and projected considerably below it, so that the apparatus, when pressure commenced, contained at the most a few small air bubbles only.

Later, when I found it was impossible to obtain certain necessary data, on account of the slowness with which pressure was got up in so large an apparatus, I procured a very much smaller apparatus of similar character, in which the cylinder was only an inch in bore, and rather less than a foot in effective interior length. With this apparatus two or three strokes, only, of the pump were required to get up the desired pressure, and there was the great additional advantage that temperatures could be independently measured by means of thermo-electric junctions. [This could not be done in the large cylinder without seriously affecting its strength, and rendering it at the same time almost unmanageable.]

(*To be continued.*)

TRANSFORMATION OF OLD COINS IN A LAKE

M. DAUBRÉE read an interesting paper on this subject at the Paris Academy of Sciences on October 17.

In the commune of Flines-les-Roches, canton of Douai, there is a small lake of very limpid water, known as the Mer-de-Flines. It is of circular shape, and about 300 m. in diameter; its surface remains stationary in position, and neither springs supplying it, nor any outlet, are apparent. The depth at the centre has not been determined. There are fishes in the lake, and the water attracts numerous bathers. Among other shells on the banks, one observes many specimens of *Unio*. The water rests on Tertiary strata of the Landenian formation, consisting of sand and gravel, with dark ashes and pyrites.

According to the researches of MM. Termink and Loustan, this lake appears to have been, in ancient times, a place of sacred resort, and various precious objects were thrown into it, as an offering doubtless to some divinity. Numerous coins, more especially, have been recovered, along with statuettes of bronze and much pottery *débris*. Of the coins, some are Gaulish, but the majority are Roman, of the time of the early Empire. They are mostly bronze, but some are of gold.

Some remarkable changes have occurred in many of these coins, and have been brought to the notice of the French Academy by M. Daubrée. The coins have been attacked and are completely enveloped with a crystalline substance formed at their expense. Their general aspect recalls that of the coins incrusted with metallic minerals, found in various thermal springs, notably at Bagnères-de-Bigorre, at Bourbonne-les-Bains, and at Baracci in Corsica.

An extremely fine external pellicle, of the brass-yellow colour which characterises chalcopyrite, first attracts notice. But the incrustation is mostly formed, to a depth of 2 mm., of a dark crystalline substance, with metallic lustre, consisting of sulphide of copper, and it is to it that the crystalline forms belong, which one might be apt, at first sight, to attribute to yellow sulphur.

The central part consists of a laminated substance. Here and there may be observed small dark hexagonal metallic crystals, in which one can see the characteristic striæ of chalcocite. The same substance forms small brilliant leaves, alternating with the dark leaves, on which appear some deposits of bright green. Heated in a tube, the crystalline substance gives a very slight sublimate of sulphur, which apparently results from the mixture of a little pyrites. The sulphide contains neither tin nor zinc.

The form of the exterior substance is that of hexagonal plates bearing truncated pyramidal faces inclined about 127° to the base. The cleavage is basic. This latter character and the

absence of macles appear to indicate the variety of chalcocite called *cuprein* by Breithaupt.

All these coins were buried in a dark brown mud, containing numerous shells, many of which have been involved in the sulphurated deposits. From analysis of a sample of the water obtained at 6·70 m. depth, it appears that, as in the thermal springs above referred to, there are no sulphides, but merely sulphates, which organic matters reduce to the state of sulphides.

The novelty in production of the chalcocite in question arises from its occurrence apart, seemingly, from thermal springs, and at a lower temperature than in the cases hitherto known.

OUR ASTRONOMICAL COLUMN

THE GREAT COMET OF 1861.—The long series of observations of this splendid comet has been very ably discussed, with the view to the determination of the most probable orbit, by Heinrich Kreutz, a pupil of Prof. Schönfeld of Bonn, and the investigation is made the subject of an inaugural dissertation in July, 1880.

The comet was discovered on May 13 by Mr. John Tebbutt of Windsor, N.S.W., but the first accurate observations for position were made at the Observatory of Sydney on May 26. On June 10 it was observed at Santiago di Chile, and on the following day at Rio de Janeiro. European observations commenced on June 30, and were continued until May 1, 1862, the later places being obtained by M. Otto Struve with the 15-inch refractor at Pulkowa: the comet was not followed at other observatories beyond February 3, when Prof. Julius Schmidt last observed it at Athens. The number of separate observations collected for the determination of the orbit exceeds 1150, and these extend, as will be seen, over a period of 11½ months, in which the comet traversed an orbital arc of more than 155°. Seeling's ellipse (period 419⅓ years) is adopted in the calculation of an accurate ephemeris for the whole extent of visibility, and the observations, freed from the effects of parallax and aberration, are compared with this ephemeris for the formation of normal places. The best available positions of the comparison-stars were previously brought to bear upon the observations, so that they have received at the hands of M. Kreutz a general revision and rectification, proportional weights being applied after a criticism of the observations at the different observatories, forty-one in number. Thus thirty-one normal positions between 1861, May 28, and 1862, April 23, were formed. The next step was the calculation of the planetary perturbations for the whole interval, and it was found that the attraction of Venus, the Earth, Jupiter, and Saturn were alone sensible; June 12 was taken for the commencement of the perturbations. The normal places being corrected for their effect, sixty-two differential equations were formed, and their solution by the method of least squares gave the definitive corrections required by Seeling's orbit, which it may be stated proved sufficiently near the truth to render provisional correction unnecessary. The orbit which the comet was describing on June 12, or about the perihelion-passage in 1861, is thus found to be as follows:—

DEFINITIVE ELEMENTS OF THE GREAT COMET OF 1861.

Perihelion passage, 1861, June 11·543949 M.T. at Berlin.

Longitude of perihelion	249° 4′ 58″·7	M.Eq. 1862·0
,, ascending node ...	278 58 53·4	
Inclination	85 26 15·3	
Eccentricity	0·9850773	
Perihelion distance	0·8223838	
Semi-axis major	55·1096±0·0330	
Period of revolution	409·40±0·367 Julian years.	

It will be remarked that the probable error of the resulting period is strikingly small.

M. Kreutz defers for the present an examination of the possible effects of planetary perturbation during the last revolution, in view of identifying the comet amongst those observed in the fifteenth century. If, however, the perihelion passage occurred in the winter it is by no means certain that the comet would be sufficiently conspicuous and favourably placed to be remarked in Europe. The following figures will afford an idea of the difficulty that would attend observations in these latitudes during the winter season. Assuming the comet to have been in perihelion twenty days earlier we have these positions for the respective dates (Eq. of 1861):—

	R.A. °	Decl. °	Distance from Earth.	Intensity of light.
Oct. 20	239·7	−17·3	1·53	0·52
Nov. 20	257·0	−20·2	1·77	0·39
Dec. 20	274·1	−20·8	1·88	0·35
Jan. 20	291·5	−19·3	1·86	0·36
Feb. 20	308·5	−15·8	1·70	0·42

In 1861, when the comet appeared as bright as a star of 4·5 mag., the intensity of light was 1·5, and it was just perceptible to the naked eye, when the intensity had descended to 0·4, but there was still a tail of 2½ degrees to distinguish it from a star, which would hardly be the case in the winter.

THE SATELLITES OF MARS.—In No. 2934 of the *Astronomische Nachrichten*, Prof. Asaph Hall has given data for ephemerides of the satellites of Mars at the opposition of 1881. The N.W. elongations take place with the following values of *u*, corresponding to the argument of latitude:—

Nov. 22	331°·7	Dec. 4	330°·3	Dec. 16	327°·1
26	331·4	8	329·4	20	325·8
30	331·0	12	328·3	24	324·5

From Prof. Hall's values of *u* it will be found that true N.W. elongations of *Deimos* occur Nov. 26·4411, Dec. 1·4886, Dec. 6·5350, and S.E. elongations Nov. 24·5480, Nov. 28·3340, Nov. 29·5957, and Dec. 3·3793 Greenwich times. On November 26 the distance of *Deimos* from the centre of the primary at elongation is 48″·7.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The last report of the Higher Local Examinations shows that in Group E (Natural Science subjects) there was a falling off of ten candidates and of two first classes this year. The examiners in Geology and Zoology give a generally favourable report. In Chemistry the practical work done was inferior, and common simple salts were not known by sight. Physiological Botany was little known; and the same remarks applied to Histology in the paper on Animal Physiology. In Group D, Political Economy showed much success, especially among some of the better candidates.

Dr. Latham and Mr. D. McAlister have been appointed members of the State Medicine Syndicate; and Mr. McAlister has been also appointed a member of the Board of Medical Studies.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, November 17.—Sir J. Lubbock, Bart., in the chair.—Sir John Kirk, K.C.M.G., was elected a Councillor, and Mr. Frank Crisp Treasurer, in place of Mr. F. Currey, deceased.—Mr. George Murray exhibited (for Col. Turberville), a bough of *Pinus pinaster*, with suppressed internodes of the lateral branches, the result of injury to the axis from which they sprang.—De Francis Day showed examples of the stomach of the pilchard, with special reference to points in their digestion. Within the pyloric division of the stomach a membranous envelope incloses the food, the latter composed of the Zoëa stage of crustaceans. What peculiar function the sausage-shaped nerves serves in the economy of digestion is uncertain.—Mr. R. J. Lynch exhibited and read a short note on the contrivance for self-fertilisation in *Roscoea purpurea*, which to some extent resembles that of *Salvia* by modifications of anther and filament.—Sir John Lubbock, Bart., then read his ninth communication on the habits of ants, bees, and wasps. He detailed experiments proving that bees prefer blue flowers to those of other colours. But again if bees have so much to do with the origin of flowers, how is it there should be so comparatively few blue ones? Sir John suggests that all flowers were originally green, and then passed through white or yellow, and generally red, before becoming blue. Ants, he stated, may live seven or eight years.—Mr. C. B. Clarke described a Hampshire orchis not represented in English botany. This pale, flesh-coloured, or yellow orchis he demonstrates is the true *O. incarnata*, Linn., and not that figured by Syme and Babington, which is the *O. latifolia*, Linn.—Prof. Cobbold described a new entozoon from the ostrich, named by him *Strongylus Douglasii*. It is said to prove de-

structive to ostrich chicks at Grahamstown and elsewhere in South Africa. The worm somewhat resembles certain free nematodes, and bears few eggs.

Mathematical Society, November 10.—S. Roberts, F.R.S., president, in the chair.—At this, the annual meeting, the treasurer read his report, from which it appeared that the Society was in a very flourishing condition. The following gentlemen were elected on the council of the present session:—President—S. Roberts, F.R.S. Vice-presidents—Dr. Hirst, F.R.S., and J. W. L. Glaisher, F.R.S. Treasurer—C. W. Merrifield, F.R.S. Hon. Secretaries—Messrs. M. Jenkins and R. Tucker. Other members—Prof. Cayley, F.R.S., Sir J. Cockle, F.R.S., H. Hart, Prof. Henrici, F.R.S., A. B. Kempe, F.R.S., Prof. Rowe, R. F. Scott, Prof. H. Smith, F.R.S., H. W. Lloyd Tanner, and J. J. Walker. Mr. W. W. R. Ball, Fellow of Trinity College, Cambridge, and the Rev. G. Pirie, Professor of Mathematics in the University of Aberdeen, were elected Members of the Society. The following communications were made:—Note on the limit to the number of different proper fractions whose denominators are less than x, where x is large, by Messrs. Jenkins and Merrifield, F.R.S.—On the oscillations of a viscous spheroid, by Prof. H. Lamb, Adelaide.—A geometrical representation of a system of two binary cubics and their associated forms, by W. R. W. Roberts.—On the infinitesimal bending of surfaces of revolution, by Lord Rayleigh, F.R.S.—On tangents to a cubic forming a pencil in involution, by R. A. Roberts.—Note on Landen's theorem, by Prof. Cayley, F.R.S.

Chemical Society, November 17.—Dr. Gilbert, F.R.S., in the chair.—It was announced that a ballot for the election of Fellows would take place at the next meeting, December 1.—The following papers were read:—Aluminium alcohols, Part II. Their products of decomposition by heat, by J. H. Gladstone and A. Tribe. The authors have studied the bodies formed when aluminic ethylate, aluminic phenylate, aluminic paracresylate, aluminic thymolate, aluminium, α naphthylate, and aluminium β naphthylate are decomposed by heat. The C_nH_{2n+1} series yields the corresponding ethers, alcohols, and olefines, the C_nH_{2n-7} series yields the corresponding ethers and alcohols, together with some new crystalline bodies which are probably ketones.—On the chemical action of decomposing vegetable matter on the rock-forming sediment of the Carboniferous period, by E. Wethered. The author points out that the rocks immediately overlying the coal are in nearly all cases argillaceous, and that in the few cases where arenaceous rocks occupy that position they have a well-marked tendency to become more argillaceous as they come into contact with the coal. He proves by analysis that the chief difference in chemical composition between the two rocks is that the argillaceous rocks contain much more alumina, and concludes that this difference in chemical composition is due to the carbonic acid evolved by the decaying vegetation, decomposing all the silicates but that of alumina.—On α and β amylam, by C. O'Sullivan. The author has exhausted various grains, barley, wheat, rye, &c., with alcohol. The residue was then treated for some time with water at 40°, and the process repeated until nothing further was dissolved. The solution was filtered, evaporated, and precipitated with alcohol. The precipitate consisted of α and β amylam. These bodies were very carefully purified; the latter is soluble in cold, the first only in hot water. They have the composition of starch, but furnish apparently dextrose at once when treated with acid, without the previous formation of dextrin or any other substance. Their optical and chemical properties are fully given in the paper.—On the action of oxides on salts, Part IV. Potassic chlorate and ferric oxide, by E. J. Mills and G. Donald. The authors conclude that the action of ferric oxide on potassic chlorate resembles its action on potassic carbonate to a certain extent, that the chemical change has nothing abnormal or peculiar in its features, and that the name catalysis ceases to have any reason for its existence.—On the steeping of barley, by E. J. Mills and J. Pettigrew. The authors have compared the effects produced by steeping barley in water, and in water containing gypsum and calcium carbonate. The general effect of a calcium solution is to retain the nitrogenous matter in the grain, but to increase the total amount of extract. They attribute the value of the Burton water to the nitrates which it contains, and the consequent stimulating effects it produces in germination.

Zoological Society, November 15.—Prof. W. H. Flower, F.R.S., president, in the chair.—Prof. Newton, F.R.S., exhibited a specimen of *Emberiza rustica* recently shot on the coast of Yorkshire.—The Rev. Canon Tristram exhibited and made remarks upon skins of a darter and a pigmy cormorant procured in June of this year on the Lake of Antioch.—Mr. Sclater exhibited a specimen of the glossy ibis (*Plegadis falcinellus*) belonging to Sir Henry Mildmay, Bart., which had been shot in Hampshire in September last.—A communication was read from MM. L. Taczanowski et J. Stolzmann on the habits and various plumages of the rare humming-bird, *Loddigesia mirabilis*.—Communications were read from M. L. Taczanowski, C.M.Z.S., on two nearly allied species of humming-birds of the genus *Steganura* from Peru, and on a new species of *Mustela* from North-eastern Peru, which he proposed to call *Mustela Stolzmanni*.—Mr. W. A. Forbes read notes on the structure of the palate in the trogons (*Trogonidæ*), and on the systematic position of *Eupetes macrocercus*.—A communication was read from Mr. E. P. Ramsay, C.M.Z.S., containing an account of the true habitat of *Pycnoptilus floccosus*, Gould.—A communication was read from Mr. E. L. Layard, F.Z.S., containing a note on the South African mollusk, *Cœliaxis Layardi*, of Angas.—A communication was read from Mr. Edgar A. Smith, F.Z.S., containing notes on the shells of the genus *Chilina*, with a list of the known species.—Mr. Arthur G. Butler, F.Z.S., read a paper on some butterflies from Japan, with which were incorporated notes and descriptions of new species by Montague Fenton.—Mr. H. J. Elwes, F.Z.S, read a paper on the butterflies of Amoorland, Japan, and Northern China.

Physical Society, November 12.—Prof. Fuller, vice-president, in the chair.—Mr. W. D. Niven was elected a Member.—Mr. Lewis Wright then read a paper on some spirals observed in crystals, illustrating the relation of their optic axes. After remarking that the relation of the axes in uni-axial and bi-axial crystals had always been an interesting subject, he observed that if we took any uni-axial and a single axis of any bi-axial which had little or no axial dispersion, and polarised and analysed each circularly, we ultimately got similar phenomena. This is illustrated by calcite and a single axis of sugar, each giving, when thus treated, unbroken circular rings. From this it might be hastily inferred that a single axis of a bi-axial resembled in character the axis of a uni-axial, but this was not the view of those who framed the theory of double refraction in crystals. Fresnel finally framed the conception of three elasticities in three rectangular directions. If all were equal, there was no double refraction; if only two were equal, there was a single optic axis in the direction of the third; and if all were unequal, there were two optic axes. According to this theory the axis of the calcite did *not* resemble in character a single axis of the sugar or other bi-axial, but was a limiting case in which *both* such axes coincided. This was illustrated by the beautiful experiment of Prof. Mitscherlich applying heat to a crystal of selenite, and thereby altering the respective elasticities. The two axes gradually approached until they coincided and the crystal became uni-axial, after which, on heating the crystal still more, the axes re-opened in a direction at right angles to the former, thus proving Fresnel's theory. A point still to be illustrated was that the axis of a uniaxial did retain, or still embraced within itself in some visible form, characteristics of the two axes thus brought into coincidence. Sir George Airy had discovered the double spiral in quartz. Uniaxial calcite showed a double spiral; and biaxials gave a single spiral. Mr. Wright repeated Prof. Mitscherlich's experiment, with Airy's additional method of analysis; the spirals being first shown perpendicularly arranged above each other. Gradually they approached until they resembled those of the calcite, and finally opened out again horizontally. All through there was a double spiral, and a single one could only be got by separating a single axis. The axis of a uniaxial always preserved what might be called its "twin" or "double" character. This experiment was the ocular demonstration sought that the axis of a uniaxial, as a limiting case, did contain or retain elements capable of being made visible. It further showed the reason of the double spiral discovered by Sir George Airy in quartz. This crystal evidently was able to show its own spirals, which, of course, are double. It was shown that as the convergence of the rings was increased these spirals became as numerous and definite as in the calcite. There was however a crucial test of this view: for if it were correct we could combine the two properties of the quartz, artificially as it were, since many fluids also possess rotary power. If therefore we took a column of such fluid of sufficient length and an ordinary uniaxial crystal, the fluid would represent the axial proper-

ties of the quartz, and the crystal the other properties, and the two ought to give similar spirals. In fact the fluid should replace the quartz successfully in all these experiments. By means of a column of oil of lemons 200 millimetres in length, and crystals of calcite, sugar, topaz, and nitre, Mr. Wright showed this to be the case. Finally he demonstrated that the same phenomena held good through all the ordinary analogies with, or artificial substitutes for, natural crystals, the figures being produced with a circular chilled glass in parallel light, and also with an artificial uni-axial crystal made of crossed mica films, after Norremberg, and an artificial quartz made of superimposed mica films, after Reusch, in convergent light. All the figures were projected by the electric camera to a size 8 feet in diameter. All Mr. Wright's experiments went to illustrate the truth of Fresnel's theory.—Mr. C. V. Boys then read a paper on the prevention of the bursting of water pipes. Mr. Powell had proposed the use of pipes of elliptical or other round section, and Mr. Mangnal of Manchester had independently hit on the same idea. Such a pipe would become rounder in section when the water froze and expanded. A round pipe tends to become thinner at its weak parts on expanding under the pressure. With an elliptical pipe, the force required to alter the shape of its section is greater as the section is more circular, therefore the effect produced by a change of shape at any place makes that place stronger. A round pipe is in a state of unstable, and an elliptical pipe in a state of stable, equilibrium, and changes its form uniformly from end to end. Hence if a portion only of such a pipe is exposed to the cold, the whole is effective, and it will require a proportionally greater number of frosts to make the pipe round. Inspection would show if the pipes were becoming round, and then they could be squeezed back to their original shape. Mr. Boys had demonstrated these inferences by experiment with Mr. Powell. Messrs. Powell, Rigby, and Co. of Piccadilly made these pipes.—Mr. J. Macfarlane Gray drew attention to some apparent discrepancies in the constants employed by Regnault in his work on "The Physical Properties of Steam."

PARIS

Academy of Sciences, November 14.—M. Wurtz in the chair.—The following papers were read:—Researches on electrolysis (continued), by M. Berthelot. He illustrates the "principle of minimum electromotive force in electrolyses," in virtue of which electrolytic decomposition occurs as soon as the sum of energies necessary is present. It is distinctly verified wherever there is no polarisation of electrodes.—The maritime laboratories of Banyuls-sur-Mer and Roscoff, by M. de Lacaze-Duthiers. The Roscoff station has had increasing success: 38 have worked at it this year, as against 27 in 1880 (there are 25 at present). The number of foreigners is eight. A large fish-pond has been added, and Government has provided a vessel for dredging. Banyuls-sur-Mer was fixed on for a winter station. The author gives particulars of what is to be called the *Arago Laboratory*, &c., which will be ready early next year. He has received 48,000 francs. The Mayor of Banyuls has opened a subscription for a dredging vessel.—Observations on the second volume of M. Fontaine's Universal History; the Iranians, by M. de Lesseps.—On the working zone of anæsthetic agents, and on a new process of chloroformisation, by M. Bert. With increasingly-strong mixtures of an anæsthetic vapour and air, a point is reached at which an animal in such an atmosphere is made insensible, and another point at which it is killed. The interval between these is the *zone maniable*, or working zone. M. Bert used chloroform, ether, amylene, bromide and chloride of ethyl, and the animals were dogs, mice, and sparrows. Under these conditions the fatal dose is precisely double the anæsthetic dose. (In the case of protoxide of nitrogen the ratio is one to three.) The zone is much greater for ether than for chloroform. Animals anæsthetised in the way indicated remain perfectly quiet and need no attention. In the common way of applying chloroform, with a compress, the limits of the working zone may be exceeded on either side. Chloroform acts, not by the quantity respired, but by the proportion in which it exists in inspired air. The author applies the mixture through a tube and a small mask. The anæsthetic dose for man has yet to be determined.—Synthesis of azotised colloids, by M. Grimaux. Proteic matters he defines as azotised colloids breaking up, through hydration, into amic acids, carbonic acid and ammonia, and from this his method of synthesis is derived. He combined aspartic anhydride with urea.—Crystallographic observations on a variety of natural blende, by M. Hautefeuille.—Observations of Schäberle's comet (*c* 1881) at Rio Janeiro Observatory, by M. Cruls.—On the theory of motion of celestial bodies, by M. Callandreau.—On certain series for development of the functions of a variable, by M. Halphen.—Equality of mean sinking produced by two equal loads (each at points where the other is deposited) arbitrarily distributed along two concentric surfaces on a horizontal ground, or on a horizontal circular plate having the same centre as these circumferences, and supported or secured throughout its contour, by M. Boussinesq.—On the maximum yield of which two given dynamo-electric machines are capable, when used for transport of force, by M. Lévy.—Researches on the absorption spectrum of our atmosphere at Paris Observatory, by M. Egoroff. He describes the absorption of strong electric light by the air-layer between Mont Valérien and the Observatory, observed on eleven evenings. It is probable that, after aqueous vapour, air is the only strongly absorbent substance.—On the electrolysis of water (continued), by M. Tommasi. All metals except gold and platinum, being able to combine with the oxygen of water under action of the voltaic current, are capable, when positive electrodes, of decomposing water by action of a single (zinc copper or zinc carbon) element. He here shows that the decomposition will occur if one of the two electrodes is aluminium, zinc, or carbon. He opposes some of M. Berthelot's views.—On the reversibility of the electro-chemical method for determination of systems of equipotential or discharge, by M. Guébhard.—On the magnetic properties of the nickelised iron of Santa Cattarina, Brazil, by M. H. Becquerel. There is great increase of magnetism after heating followed by cooling, and the author got a like result with pure nickel crystallised in the cold state; but not with pure iron. The native iron must have crystallised at a low temperature.—On the proportions of carbonic acid in the high regions of the atmosphere, by MM. Müntz and Aubin. The observations, made on the Pic du Midi (2877 m.) gave 2·86, which is extremely like the figure got on the plain of Vincennes, and similar figures were got in two Pyrenæan valleys.—On the post-embryonal development of Diptera, by M. Viallanes.—The pourridium of vines of Haute-Marne, produced by *Ræsteria hypogæa*, by M. Prillieux.—Bauxites, their age and origin; complete diffusion of titanium and vanadium in rocks of primordial formation, by M. Dieulafait.

VIENNA

Imperial Academy of Sciences, November 3.—L. T. Fitzinger in the chair.—The following papers were read:—A. D'Albert Adamkiewicz, on the blood-vessels of the spinal cord of man, Part II. The vessels of the spinal marrow.—E. Heinricher, contributions to the teratology of plants.—E. Tangl, on nucleus and cell division in the formation of pollen of *Hemerocallis fulva*, L.

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THURSDAY, DECEMBER 1, 1881

THE ACCIDENTS IN MINES COMMISSION

THE Preliminary Report of this Commission, recently issued, affords a rather striking illustration of the amount of unpaid work which is occasionally done for the public by our busiest men. The Commission was appointed to inquire whether "the resources of science furnish any practicable expedients not now in use which are calculated to prevent the occurrence of accidents in mines or limit their disastrous effects." In its constitution science was represented by the following Fellows of the Royal Society:—Mr. Warington Smyth, Prof. Abel, Prof. Clifton, and Dr. Tyndall. The employers were represented by Sir George Elliot, M.P., Mr. William Thomas Lewis, and Mr. Lindsay Wood; the employed by the Member for Morpeth, Mr. Burt. Earl Crawford (then Lord Lindsay), who was added by a subsequent Royal Warrant, combined the man of science and the employer. He is a Vice-President of the Royal Society, and is largely interested in mining industry. Mr. Warington Smyth was very properly selected by the Home Secretary to preside over the Commission, for his scientific attainments are supplemented by varied and accurate knowledge of practical mining

The Commissioners set about their work in the most thorough manner. "In order to ascertain in what direction they could most usefully prosecute their inquiry," they "obtained the best possible evidence on the circumstances under which mines are worked, and on the acknowledged or probable causes of accident." They examined all the inspectors of mines, a large number of experienced colliery viewers and mining engineers, and a number of workmen selected by the miners' associations. They visited and inspected collieries in all parts of the kingdom, including most of those in which explosions of serious magnitude have recently occurred. At an early stage of their inquiry they found that they must make a series of extensive experiments, "involving much time and labour." They did not hesitate, they say, to "enter upon these experimental researches," and "there is good reason to hope," they add, "that their prosecution will result in the development, and perhaps in the settlement of, important questions bearing upon the elimination of accidents in mines."

In the meantime, as these experimental inquiries must necessarily take some time, they have thought it best to present at once the evidence which has been taken by them.

This evidence is preceded by a very interesting summary: One of the most important facts to which they draw attention is the great improvement which, so far as safety is concerned, has taken place during the last thirty years. Whilst the total number of deaths remains almost the same, the number of persons employed has nearly doubled, so that the fatalities have been reduced by nearly one-half.

These satisfactory results—as they point out in detail—are due to the scientific treatment of the various problems involved in underground operations, and to the increased care and regularity exercised generally by workmen and officials in the daily routine of their work.

The body of evidence which they have presented is full of interest and importance to all who are concerned in this great branch of our industry, whether as colliery owners, officials, or workmen. It has evidently satisfied the Commissioners as to the direction in which they must prosecute their inquiry, and as to the scientific problems which still remain to be solved. The source of danger which has hitherto defied all the efforts of science is the existence of light carburetted hydrogen gas—popularly known as "fire-damp"—in the coal. Falls of roof and side cause more than half the fatal accidents in mines. But a fall of roof never exacts more than one or two victims, and attracts scarcely any attention. The issue of fire-damp from the coal may—and often does—destroy hundreds of lives at a time, with a sudden, swift, and awful explosion, which strikes a natural terror into the whole mining population.

Wonderful as have been the recent improvements in ventilation, which are described in this Blue Book, the enormous volumes of air obtained by the best constructed furnaces or the most gigantic fans are unable to cope with the "sudden outbursts" of gas, which appear to increase in number as the deeper measures are reached. Recent experiments made by one of the Commissioners—Prof. Abel, at the request of the Home Office, and described in the summary—have revealed another danger, which improved ventilation may, under some circumstances, increase rather than diminish. From these experiments it appears that the presence of coal dust in the air of a mine renders it explosive if the air contains a proportion of fire-damp so small that it cannot be detected by the most experienced observer with the means at present in use. Here it is that the Commissioners appear to consider that patient research and experiment may be of some avail. Fire-damp is harmless unless it be ignited. The only two ways in which it needs be ignited are by the lights used for lighting the mine and by the explosives used for driving headings and bringing down the coal. If a method of lighting could be devised which would not ignite an explosive mixture of fire-damp, all danger in that direction would be removed. If an explosive or other equally efficacious agent were devised which would not ignite such an explosive mixture, all danger in that direction would be removed. The Commissioners have had the electric light introduced experimentally at the Pleasley Colliery, near Mansfield. But though they say that an admirable illumination was obtained with Swan's electric lamps, they add that "further experiments and a full examination into all details connected with its application are needed before it can be decided whether the electrical illumination of workings is practically achievable."

With reference to the existing system of lighting by safety lamps, the Commissioners afford another instance of laborious inquiry. They found a powerful blower of natural gas at Mr. Smethurst's Garswood Hall Colliery, near Wigan. Here they had suitable apparatus put up, and made several hundreds of careful experiments with about fifty varieties of safety lamps, for the purpose of determining the relative safety of each variety. Not satisfied with those, they say it will be desirable "to carry on these experiments in further detail, and to repeat them in other localities with other varieties of fire-damp." We understand that the Commissioners have nearly completed

arrangements for continuing these experiments at the Llwynpia Colliery of the Glamorgan Coal Company, where there is a large blower of natural gas.

On the subject of the other source of danger they make the following observations:—"The use of gunpowder and other explosives is at the present day so widely spread, and is held by many to be so indispensable, that all suggestions for checking their application in certain cases on account of risk need to be very carefully weighed." "An overwhelming majority of our witnesses assert that it is practically impossible, as a rule, to work mines without powder." They conclude however a review of the evidence on this subject with the following rather significant statement:—"In the meanwhile it has appeared to us to be desirable to make trials of such methods of 'falling' or bringing down the coal as may do away with the danger caused by sparks and flame; and with this view a series of experiments already commenced will be continued in different localities"

The result of these further inquiries and experiments with reference to lighting and blasting, it is of course impossible to forecast. We fear it would be rash even to hope for an announcement that for the future fiery seams may be worked with a light, and brought down by an explosive, neither of which can ignite an explosive mixture, and both of which can be readily adopted without adding to the cost of getting the coal. But we await with much interest the conclusion of an inquiry which has been conducted in such a thoroughly scientific manner, and upon which so much practical experience, time, and labour have been bestowed.

CELESTIAL OBJECTS FOR COMMON TELESCOPES

Celestial Objects for Common Telescopes. By the Rev. T. W. Webb, M.A., F.R.A.S. Fourth Edition, revised and greatly enlarged. (London: Longmans, Green, and Co., 1881.)

THIS is a new and much extended edition of a work which has attained considerable popularity amongst the many amateurs of astronomy in this country who are limited to the use of instruments of moderate optical capacity, or as the author terms them, "Common Telescopes." By this term are intended achromatics with aperture of from three to five inches, or reflectors of somewhat greater diameter, yet as telescopes of higher pretensions are now in the possession of private observers, the author in the selection of additional objects has aimed at including such as may be considered tests for a superior class of instrument. The increase in telescopic range applying chiefly to the sidereal branch of astronomy, the additions have been taken for the most part from the works of the Struves and Burnham for double stars, and Sir John Herschel's catalogue for nebulæ: the total increase in the number of objects brought together in this new edition over the preceding one, is stated to be about 1500.

The first part of the work relates to the solar system, with a popular account of the actual state of our knowledge of the characteristics of its various members, so far as they fall within reach of moderate telescopes. In treating of the sun, the author collects many cases of the observation of dark spots in motion upon the disk, including that recorded by Mr. Capel Lofft of Ipswich, in January, 1818, to which, if we mistake not, attention was first specially directed by Mr. Webb in an earlier edition of the present work. He reproduces Pastorff's drawings of what he supposed to be the great comet of 1819, in transit across the sun, on June 26, taken from the originals, which are in the possession of the Royal Astronomical Society. The *phosphorescence of the dark side* of Venus, a phenomenon not as yet satisfactorily explained, is dwelt upon, as also the problematical satellite assigned to this planet. The moon is the subject of detailed description, the peculiarities of her surface, and the various craters, walled plains, valleys, clefts or rills, annular mountains, &c., are brought together in an interesting form; a map of the lunar surface forms the frontispiece to the volume, and a full index to the five hundred spots marked upon it, with an "Alphabetical Table of Lunar Nomenclature," is amongst the contents: indeed our satellite forms the subject of special treatment, which is amongst the most notable and useful features of Mr. Webb's work. An outline chart of the surface of Mars follows, with the actual nomenclature, which we hope at no distant time to see placed upon a more satisfactory foundation. The principal points of interest furnished by telescopic observation of the disks of Jupiter and Saturn are referred to, though, from the limited space at disposal, in less detail than the reader might perhaps desire. Cases of visibility of the brighter satellites of Uranus, and the satellite of Neptune, with telescopes of moderate dimensions, are recorded.

After a brief notice of comets, the author passes to the main division of his work—sidereal astronomy, or, as he phrases it, "The Starry Heavens,—Double Stars, Clusters, and Nebulæ." In this division, as it appears to us, Mr. Webb is at a disadvantage in being compelled to employ a system of abbreviation which, in the eyes of some readers, will not be without its disadvantage: but he has been perfectly aware of this, and in his Introduction asks the reader "to excuse a condensed form of expression, the result of necessity rather than of choice"; the amateur who intends to make practical use of the work must therefore accustom himself at the outset to Mr. Webb's abbreviations, and it must be admitted that it would have been difficult, without some such system, to have given the amount of information which is contained in the 300 pages or less, devoted to stellar astronomy. Mr. Webb follows the convenient plan of taking the constellations in alphabetical order, so far as they are visible in these latitudes: telescopic objects in the southern heavens are only noticed in a short appendix. The positions of the various objects are given to the nearest minute of time only in right ascension and the nearest minute in declination, but it may be remarked that the former is not a sufficiently close indication of the places of several interesting objects which fall well within the scope of observation of many amateurs, whom it might be desirable to enlist for their more systematic observation. We allude to cases like that of Tycho Brahe's star of 1572, Kepler's star of 1604, or Anthelm's in 1670. For the former the author gives R.A. 0h. 19m., Decl. 63° 24′ N., and recommends that a minute star near the place should be watched; but any one acquainted with the neighbourhood will know that a

closer indication of its place is necessary for the identification of the suspicious object: it is the same with the small stars near the positions of Kepler's and Anthelm's stars. Variability has been remarked in small stars which occupy places very close to the observed positions of Tycho's and Anthelm's stars, and probably also in the case of Kepler's, and it is very desirable that a strict scrutiny of these spots should be maintained. As happens in so many popular treatises, there is a confusion in Mr. Webb's statement with regard to Kirch's variable star χ Cygni (Bayer): the Greek letter is attached at p. 288 to the double star No. 2580 of Struve, and it is added, "About $4^m f$, 50's is 17, or χ Bayer, discovered by Kirch; 1686, to be var., sometimes up to 5m.," &c. It is, however, Flamsteed's 17 Cygni which corresponds to Struve's double-star, while the variable star is χ Cygni of Bayer. Flamsteed, it is true, attached the letter χ to his 17 Cygni, though, as was pointed out by Argelander many years since, through a mistake: he saw no other sufficiently bright star near the place to correspond to Bayer's, but the explanation of this circumstance is found in the fact that at the dates of Flamsteed's observations "the variable star was down," to borrow an expression with which observers of these objects will be familiar, so Flamsteed seized upon the nearest naked-eye star for Bayer's χ. Mr. Webb dwells particularly upon the colours of the double-stars, one of their most interesting characteristics, and has brought together a large number of attractive notes upon the objects which he includes in his survey of the northern heavens. That his volume will maintain its popularity amongst amateur astronomers is not to be doubted, and we must add that it well deserves to do so.

CARNAC

Excavations at Carnac. By James Miln. (Edinburgh: Douglas, 1881.)

MR. MILN, to whom we are already indebted for a work on Roman remains found near Carnac (Britanny), has continued his researches in this interesting locality, and has given us a second work, consisting of a record of archæological researches in the alignments or stone avenues of Kermario.

The alignments of Kermario consist of ten rows of undressed stones, which extend for about two miles in an easterly direction, after which begin the avenues of Kerlescant. The stones, which consist of a close-grained granite, are some of them as much as twenty feet high, though the majority are much smaller. At the base of many of them Mr. Miln found ashes, charcoal, and fragments of pottery of a character which led him to the conclusion that these mysterious and almost unique avenues of stones were erected as sepulchral monuments. Although the whole monument is of such an extensive character, Mr. Miln is of opinion that it had not been completed. He draws this inference from the fact that in the neighbourhood he found several heaps of long stones, which he supposes had been brought there in order to be erected.

Among the stone avenues run certain ancient earthworks, and at the head of them are, as Mr. Miln found, the remains of ancient buildings. It was in these earthworks, at the base of the menhirs (which however he was very careful not to overturn), and among the ruins of these buildings that Mr. Miln's excavations were carried on.

The principal interest of the objects discovered in his researches, is the evidence they afford as to the period at which these menhirs were erected, and Mr. Miln comes to the conclusion from the result of his investigations that between Kermario and Kerloquet we have a long stretch of defensive works erected by the Celts at a period anterior to the Roman invasion; that the Romans on their arrival had occupied some of these, and in the more advantageous positions had constructed other works of greater solidity. On the other hand there seems some evidence that the erection of standing stones or menhirs did not altogether cease at this period, for under some of them, and in positions which would seem to show clearly that they were placed there at the time the menhirs were erected, fragments of Roman tiles and pottery have been discovered. These menhirs, however, formed no part of the "alignments."

It is interesting that, as Dr. Closmadeuc had already pointed out, we have evidence that there has been a change in the level of the land since the erection of these monuments. Mr. Miln considers that nearly the whole, if not the whole, of the bay of Quiberon must then have been dry land. On the Quiberon side of the bay the rows of menhirs extend under water, and on the Carnac side too, Gallo-Roman potters' furnaces have been found below high-water mark.

We much regret to add that the author died the very day after he had finished the proof sheets of this work. The present writer had the pleasure of examining Mr. Miln's excavations with him in the autumn of 1877, and may be permitted to add his personal expression of regret at the loss which archæological science has experienced in his death.

OUR BOOK SHELF

The Mind of Mencius. By the Rev. E. Faber. Translated by the Rev. A. B. Hutchinson. (Trübner's Oriental Series. 1881.)

MR. FABER is already well known in the field of Chinese studies by his digest of the doctrines of Confucius. In the present volume he gives us a systematic digest of those of Mencius, the greatest and most popular of the disciples of Confucius. These two philosophers form the bulwarks of Chinese conservatism, against the doctrines of socialism and communism, which first thrust themselves into notice after the death of Confucius. These men, as the translator remarks, made no appeal to external credentials; they rather based the truth of their mission on the conformity of their doctrines with the essentials of the human mind, as shown by observation. To them the "state" is everything—it is "the sum of all human endeavours, natural and civilised, working together as a united organisation." For about 3000 years the political fabric of China, based on the principles of which Confucius and his disciples were the exponents rather than originators, has held together in spite of shocks before which any other system known in history would have disappeared, and at the present day seems as vital and vigorous as at any portion of its existence. To explain by the light of the best commentators what these principles, as enunciated by Mencius were, is the object of Mr. Faber. This philosopher was a contemporary of Plato and Aristotle, but his doctrines are still living and active principles in Chinese ethics and politics. The

value of this work will be perceived when it is remembered that at no time since relations commenced between China and the West has the former been so powerful—we had almost said aggressive—as now. She is drawing closer to us as time goes on, but there is no evidence that the tenacity of her hold on her ancient political doctrines is relaxing. For those who will give it careful study Mr. Faber's work is one of the most valuable of the excellent series to which it belongs.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Primitive Traditions as to the Pleiades

In Dr. Tylor's recent review in NATURE (vol. xxiv. p. 529) of Mr. Dawson's work on the "Folk-Lore of the Natives of Victoria," he refers to their tradition of "the lost Pleiad," and assumes that it must have been borrowed by them from Europeans. The indefatigable Astronomer Royal for Scotland, conceiving that my researches as to the Pleiades, and especially as to traditions respecting those stars among the Australians, had been improperly ignored, wrote a letter to the Editor of NATURE, which, having been submitted to Dr. Tylor, was sent to my Canadian address, with his reply, by Prof. Piazzi Smyth, and has only reached me within the past week.

Dr. Tylor states that he has frequently heard of my researches respecting the Pleiades, but has never met with any publication of mine on the subject; and that he would be much surprised if I could show that the story of the "Lost Pleiad" is really a primitive and original myth of savages.

Before touching on that point I think it but right to say that, so far from feeling aggrieved by the omission, I am afraid that I rather owe an apology to Dr. Tylor and to anthropologists for not having long ago published the results of my labours.

If a paper on the subject would have been only read and used by Tylors and F.R.S.s, I should long ago have given them the substance of the fruits of my investigations. Unfortunately there are scores of imaginative persons who have a fondness for discussing scientific novelties, without having the caution and training necessary for such work. Hence the unfortunate discoverer or explorer of any new and difficult field of research is apt to find that, long before he feels justified in inviting the attention of the scientific world to his favourite subject, it has been invaded and discredited by hasty theorists; and that his first work is the unpleasant task of clearing the field of the rubbish with which it has been encumbered.

Now there are few subjects as to which greater caution is needed than that of anthropology, and especially that branch which deals with the myths and religious ideas of savages. Dr. Tylor's works are therefore very satisfactory, as they contain a vast mass of facts, and evince an entire absence of fanciful or hasty theories. Had I confined my researches to the study of the folk-lore of savages I should never have supposed that the Pleiades deserve the prominence which my conclusions have assigned to them.

As my researches are unknown to most persons, and only imperfectly known to a few through my privately printed journals of investigations, letters, &c., having been partially published by others, permit me to explain the course of my investigations, and the grounds for my conclusions as to the Pleiades and their influence on the calendars and mythologies of nations.

It is now almost a lifetime, some thirty years ago, since I first noticed the universality of the number *seven* on ancient symbolism. As seven stars frequently met me as an architectural symbol, or a religious emblem in the New World, as well as in the Old, sometimes too in connection with the prehistoric cross, I suspected that these stars must have been the Pleiades, and that they must have in some way consecrated that symbol and the number *seven*, a number, too, which I had noticed as being prominent in the grouping of some prehistoric structures. Why such apparently unimportant stars should have once acquired such world-wide significance I was utterly unable even to offer a conjecture.

After corresponding with Mr. Prescott, Sir Austin Layard, and others on this subject, I made up my mind that I had got hold of the wrong end of a very important inquiry, and that for years to come I must carefully collect facts and religiously avoid hasty generalisation.

On subsequently paying my first visit to England the late Sir Henry Ellis, the editor of "Brand's Popular Antiquities," requested me to prepare a paper on the coincidences of customs among savages and civilised nations, and I accordingly selected those connected with the Feast of Ancestors, as I found that my references and notes on it were very numerous.

I had previously noticed that a Spanish Jesuit missionary had expressed surprise that the Peruvians and Christians observed the feast of the dead on the same day—the second of November. I of course looked on the coincidence as purely accidental, but when I had written a paper giving the results of my notes, to my great amazement I found that this coincidence was very widely spread, and that the feast of ancestors was very generally held about the beginning of November. Here then was a truth not hitherto "dreamed of in our philosophy"; and I therefore thought it prudent to defer reading my paper until I could solve the mystery.

How could this singular coincidence have been caused and preserved throughout the world, in the northern as well as in the southern hemisphere? It was plain that this festival must have been regulated by something very simple and plain, such as the rising of some star. If this was the case, then it was equally clear that that star must have been very carefully observed throughout the world, and may therefore have become an object of peculiar reverence. I at once thought of the widespread symbolism of the Seven Stars, which I had long before noticed, and therefore, as I was not an astronomer, I asked Prof. Everett, F.R.S., then a professor in King's College, Windsor, Nova Scotia, whether the Pleiades could ever have risen in November. He of course replied in the negative, for it must have been at least twelve thousand years since those stars rose heliacally at that time of the year. I had, however, my conjecture fully confirmed by finding that in one of the most ancient calendars in the world, that of the Brahmins of Tirvalore, the name of November was *Kartica* ("the month of the Pleiades"). I subsequently found a year, still in use in Polynesia, regulated by the rising of the Pleiades at sunset, or by their being visible all night long, and I also discovered that the three days' feast of the dead was also held in November by the Australian savages as a great annual corroboree in honour of the Pleiades. Since then I have found this primitive calendar, or fossil traces of it, all over the world.

I also found that early astronomers constructed great years or cycles on the basis of this simple calendar, which were also regulated by the Pleiades. With this calendar and its festivals and these cycles I found flood traditions and primitive myths associated, and that the key to some of the most remarkable features in early religions and traditions is to be found in the year of the Pleiades.

In 1863 I printed privately a paper of 103 pages on the Feast of the Dead, and the calendar of which it was a new year's festival, and in 1864 a second paper on the connection of the Pleiades with the cycles of the ancients and with prehistoric chronology.

As Prof. Piazzi Smyth, in 1865, was intending to carefully measure and examine the Great Pyramid, I sent him a copy of my papers, as I believed that my early impressions as to the connection of the Pleiades with primitive architecture would prove to be well founded. In his work on the Pyramid he republished seventy pages of my first paper, my request that it should not be published having fortunately reached him too late.

My excuse for this long delay is the desire, before publishing my conclusions, to work out many interesting problems connected with the Pleiades and early myths and religious beliefs, and the great difficulty of such inquiries; for the era when the Pleiades thus left their impress on the calendars and traditions of nations must be very remote, so much so that such researches are like investigations into the fossils that tell of organisms that lived in a world and breathed an atmosphere different from our own.

I am, however, preparing at last to bring out a work which will deal with the connection of the Pleiades, first, with the calendars, festivals, and cycles of nations; and next, with the myths and traditions associated with the year of the Pleiades. I

had recently intended to have published some articles which I had prepared on the connection of the Pleiades with primitive ideas as to Paradise, but it seemed prudent to defer doing so, and to bring out the whole subject in one volume. To show, however, how widely spread these traditions as to the Pleiades are, I may attempt to give the information which Dr. Tylor invites, as to the myth of the lost Pleiad being a heritage among savages. Those stars are only apparently six, yet all the world over, among civilised and savage races, in Europe, in India, China, Japan, America, and Africa, this diminutive star group is not merely regarded as seven stars, but what is still more surprising, as "*The* Seven Stars," though the far brighter seven stars of the Great Bear might seem to deserve the title.

There are various myths to account for the missing Pleiad, but one I think will suffice to show that the Australians did not borrow the idea from Europeans.

I once asked a native of the Gold Coast, a negro Hercules in strength, who had therefore been christened (probably by some pious naval officer) *Fivehorsepower*, whether he knew anything of the stars. "No!" he replied, "I know nuffin about de stars." "But don't you know anything of 'the seven stars'?" "Oh yes, of course," he answered; "every nigger knows de seben stars." "Why do you call them seven?" I asked him; "can you count seven stars?" "No," he replied, "you count one, two, three, four, five, six; then todder one hide herself, no let you count her." There is also a savage tradition, which I can recollect, that the Pleiades are young women, six of whom are very beautiful, but the seventh is so plain that she conceals herself from sight.

Some tribes of the Australians dance in honour of the Pleiades, because "they are very good to the black fellows." Was this borrowed through Europeans from "the sweet influences of the Pleiades" which Job celebrates?

Ask a negro in the Southern States to look through a telescope, and he will invariably turn it towards the Pleiades, "for they are berry good to the darkies." The natives of America, both North and South, regard the Pleiades as beneficent stars, and dance in their honour. "Oh what do we owe to thee!" is the grateful salutation of one tribe. Whence then did this arise? It was not merely because those stars announced spring, and were "stars of rain," or because they were "for signs, and for seasons, and days, and years," but also because they were connected with the idea of Paradise and the abode of the Deity. The problematical theory of Moedler, that Alcyone, the brightest of the Pleiades, is the central sun of the universe, is most interesting on account of the singular fact that such was actually the belief of early ages. I have within the past year found unexpected, and I think conclusive, proofs that the name *Alcyone* (or rather, *Alkyone*), meaning a centre, pivot, or turning-point, was not given without some reason to that star, for the ancients in very remote ages undoubtedly believed that it was the centre of the universe, and that Paradise, the primæval home of our race and the abode of the Deity and of the spirits of the dead, was in the Pleiades, traces of which ideas we even find among savages.

The *Alkyonic* Lake, the waters of which led to the world of spirits, must have meant simply "the waters of death" leading to Alkyone or Paradise, and reminds us of Ulysses' voyage to the abodes of the dead and to the Gardens of Alkynöos.

With the Pleiades, too, sacred birds (birds of paradise) were connected. In my journal of researches (1863) I expressed my conviction that *Manu* (a word meaning, in the Indian Archipelago, a fowl or bird) would be found to have been connected with the Pleiades. I have been recently gratified at finding that in far-distant Samoa there is a sacred bird called, not *Manu-alii*, the royal bird, as some European writers have assumed, but *Manu-lii*, the bird of the Pleiades.

What a singular link we have here between the folk-lore of these savages and that of the Old World, for to this very day, from Britain to Japan, the Pleiades are popularly known as "the hen" or "hen and her chickens."

In Mexico the beautiful kingfisher was a sacred bird. May not the name of the same bird in Greece have been a survival of similar ideas, as it was called the *Halcyon, i.e.* belonging to Alcyone, or a bird of paradise?

The bright sunny days, too, at the end of autumn, that shining season of the Pleiades, called in America the Indian summer, were *Halcyon* days among the Greeks, which we should now render heavenly days.

Even if the theory of prehistoric astronomers and of some modern men of science, that the Pleiades are the centre of the universe, should prove to have been unfounded, I am persuaded that the day is coming when the learned will admit that those stars are the "central sun" of the religions, calendars, myths, traditions, and symbolism of early ages—an era, however, so marvellously remote, that investigations respecting it bear the same relation to the study of anthropology and to the science of religion that palæontology does to natural history.

I shall be greatly disappointed if I cannot satisfy even so cautious and careful an observer as Dr. Tylor, that there is a mass of original and primitive traditions as to the Pleiades among isolated savages in various quarters of the globe.

In the meantime, until these conclusions are submitted in a proper and scientific shape to the learned, Dr. Tylor is perfectly justified in adopting the prudent legal maxim, *De non apparentibus et non existentibus eadem est ratio.*

I may however invite his attention to Mr. Ernest de Bunsen's recent work on the Pleiades—"The Pleiades and the Zodiac," published in German (Berlin, 1879), and his recent learned work, the "Angel Messiah." The former he has kindly dedicated to me as the pioneer in this new and difficult field of research.

R. G. Haliburton

The Pronunciation of Deaf-mutes who have been Taught to Articulate

In Nature (vol. xxv. p. 72) it is reported that at the last meeting of the French Academy M. Hément made some observations to show that deaf-mutes who have been taught to articulate speak with the accent of their native district. This curious circumstance, which was contested by M. Blanchard, has already been recorded. One case is given in an old number of the *Philosophical Transactions*, No. 312. About the age of seventeen a young man, a congenital deaf-mute, was twice attacked by fever. "Some weeks after recovery he perceived a motion of some kind in his brain, which was very uneasy to him, and afterwards he began to hear, and, in process of time, to understand speech. This naturally disposed him to imitate what he heard, and to attempt to speak. The servants were much annoyed to hear him. He was not distinctly understood, however, for some weeks; but is now understood tolerably well. But what is singular is that he retains the Highland accent, just as Highlanders do who are advanced to his age before they begin to learn the English tongue. He cannot speak any Erse or Irish, for it was in the Lowlands he first heard and spoke." The curious circumstance of his possession of the Highland accent is confirmed by the testimony of similar phenomena in the deaf and dumb schools of Spain. "One fact," says Ticknor, "I witnessed, and knew therefore personally, which is extremely curious. Not one of the pupils, of course, can ever have heard a human sound, and all their knowledge and practice in speaking must come from their imitation of the visible mechanical movement of the lips and other organs of enunciation by their teachers, who were all Castilians, yet each speaks clearly and decidedly, and with the accent of the province from which he comes, so that I could instantly distinguish the Catalonians and Biscayans and Castilians, whilst others, more practised in Spanish, felt the Malagan and Andalusian tones" ("Life and Journals of George of Ticknor," vol. i. p. 196, London, 1876). A similar case has been mentioned to me by Mr. J. J. Alley of Manchester. E. R. became deaf and dumb at a very early age, and did not talk until he was about seventeen, when he was taught articulation by Mr. Alley. He speaks with the accent of his native county of Stafford. These facts are cited in my paper on "The Education of the Deaf and Dumb," in the "Companion to the Almanac" for 1880.

William E. A. Axon

Tanganyika Shells

In the *Proc.* Zool. Soc. Lond. for May, 1881, pp. 558–561 Mr. Edgar A. Smith has described two new species of shell from Lake Tanganyika, Africa, for which he has proposed the new generic name of *Paramelania*. These forms are, without doubt, generically identical with the *Pyrgulifera humerosa* of Meek (see U.S. Geol. Sur. 40th Parallel, by Clarence King, vol. iv. p. 176, pl. xvii. Figs. 19 and 19*a*), which antedates Mr. Smith's name by at least five years. Mr. Meek's species has hitherto been the only known member of the genus, either fossil or recent, and was only known to occur in the strata of the

Laramie group, an extensive brackish water formation in Western North America, which holds a transitional position between the Mesozoic and Cenozoic series. Associated with *Pyrgulifera humerosa*, among various other fresh and brackish-water forms, is one that I have described under the name of *Goniobasis cleburni*, which is evidently congeneric with the *Melania* (*Sermyla*) *admirabilis* of Smith, an associate of *Pyrgulifera damoni* and *P. crassigranulata* in Lake Tanganyika. As that lake has evidently once been a brackish water sea, it is not strange that there should be certain similarities between its molluscan fauna and the faunæ of similar bodies of water that existed in Mesozoic and Cenozoic time. It is, however, remarkable that the two generic types here especially referred to should appear in their integrity living in Africa, and not in North America, where the fossil forms occur; and especially so because so many of the fresh-water and land-molluscan types now living on the latter continent are found fossil in its Mesozoic and Cenozoic strata. C. A. WHITE

Washington, D.C., November 4

Velocity of Wind

THE following observations regarding the velocity of the wind in the south-west gale of the 21st and 22nd of November at Edinburgh may be of interest. The observations were made by me about nine o'clock on the morning of the 22nd, when the wind had somewhat moderated :—

	Miles per hour.
Mean velocity	62·3
Velocity during a squall	71·6

These observations are calculated from the velocity of clouds of *smoke* issuing from the chimney of the Caledonian Distillery, and travelling for a distance of 2100 feet, and are thus free from instrumental errors. The chimney is 225 feet high, and its base is about 200 feet above the sea-level.

CHARLES ALEX. STEVENSON

Arctic Research

No one can hold in higher honour and respect than I do the opinions of the greatest of Arctic navigators, Sir Edward Parry, although these opinions were expressed more than half a century ago, since when our knowledge of Arctic shores has very materially increased.

My letter in NATURE vol. xxv. p. 53, where alluding to navigable waters through channels, &c., in the Arctic Sea, specially referred to Arctic America and the lands lying north of it, in which category Greenland can scarcely be included, certainly not that part of its western shores along which a navigable passage is almost invariably to be found.

The following passages from the extract from "Sir Edward Parry's writings" (NATURE, vol. xxv. p. 78) are those which specially bear upon the statements made by me :—

"We experienced a striking example of this kind [ice obstruction] in coasting the eastern shore of Melville Peninsula in 1822 and 1823, the whole of the coast being so loaded with ice as to make the navigation extremely difficult and dangerous."

I do not in the least doubt this, but difficulties of ice-navigation are comparative, and I believe from Eskimo report that the opposite side of Fox's Channel would have been worse. On asking the natives of Repulse Bay why they did not go over to Southampton Island, which forms the eastern shore (having a western aspect) of Sir Thomas Roe's Welcome, the reply was, there were no seals or walruses there, the ice being too much on shore. The same is said of the east side of Fox's Channel.

The sea on the west side of Melville Peninsula is said never to be free from ice[1]; such was its condition during the summer of 1846; and in 1847, when I traced its whole shore, there was a fringe of heavy and rugged hummocks some miles wide all the way.

In the springs of 1847 and 1854 the opposite coast, being the west side of Committee Bay—having an eastern aspect—bore evidence, by the small quantity of rough ice met with, that there had been navigable water at some time during the previous summer.

There can, as a rule, be no better or truer guide to the *side* of a channel, inlet, &c., which is *least* ice-obstructed than the assembling of marine animals, seals, walruses, and whales (provided always that these animals have not been driven away by constant attacks to less favoured resorts) along its shores, on which the Eskimos have their chief camping-grounds, and of

[1] See Rae's "Arctic Expedition," 1846-7, p. 49.

which there are many along the east shore of Melville Peninsula and southward on the same coast-line to lat. 64°, near which the Americans have had their chief whaling and sealing stations for many years.[1]

On August 19 and 20, 1859, Sir Leopold McClintock ran 150 miles down Prince Regent's Inlet, along the side, having an eastern aspect, to Bellot Strait, without seeing a bit of ice except one large iceberg, and returned by the same route in 1860 (August 10 to 16), but on this occasion was stopped near Fury Point by ice, forced in by a strong easterly breeze of four days' duration; when the wind changed to west the obstruction was speedily removed, and there was no farther difficulty. Dundee whalers have not infrequently visited Cresswell Bay in this locality, and killed whales there. So much for shores having an eastern aspect being navigable, notably that of Smith Sound.

The second passage from "Parry's Writings" I wish to comment upon is—

"These facts, when taken together, have long impressed me with the idea that there must exist in the Polar regions *some general motion of the sea towards the west*, causing the ice to set in that direction, when not impelled by contrary winds or local or occasional currents."

When it can be proved that permanent currents exist in the sea, irrespective of wind influence, we must naturally assume that the motion of the sea and of the ice floating on it is in the same direction.

The *Resolute*, one of Sir Edward Belcher's ships, abandoned near the south entrance of Wellington Channel in 1854, must have driven eastward for 300 miles through Barrow Strait and Lancaster Sound, into Baffin's Bay, and was picked up far to the south by the Americans some years afterwards.

Sir Leopold McClintock in 1859 and 1860 found Bellot Strait free from ice, and quite navigable, entering from the east, but impenetrably blocked with thick old ice-floes at its western extremity. In his chart is a note: "Bellot Strait, flood and *permanent* current to eastward."

Sir Edward Parry experienced a somewhat similar permanent easterly current in the Strait of the Fury and Hecla, as the following extract from Capt. Lyon's (who commanded one of Parry's ships) journal (p. 275) will show: "That there was a prevailing set from the westward we had long known, even before entering the strait, and we saw by the driving of the loose ice against an easterly wind that it ran with great force. As an extraordinary instance in point, the *Hecla* broke adrift on the 13th in consequence of a piece of ice parting, and was carried (eastward) against a fresh easterly breeze, about a mile from the fast floe. All sail being set before the wind, we were nearly two hours in recovering this one mile, though to all appearance and by the log going between three and four knots through the water."

Here are examples of two permanent currents running to the east, through straits narrow, it is true, but the only passages known to exist in two lands extending about six degrees, or 360 miles north and south.

The conclusion to be arrived at seems to be, that the sea to the west of these lands is at a higher level than it is to the east of them, and consequently if the general motion of the "sea is towards the west," according to Sir Edward Parry's idea, it must, in the localities named, be moving in opposition to its own currents, or up hill. J. RAE

4, Addison Gardens, November 26

ARE not the facts of ice-accumulations at "the western sides of seas or inlets," mentioned in your last number (p. 78), to be explained by reference to Baer's law for the flow of rivers? This law, corroborated by many observers in all parts of the world (see for instance NATURE, vol. xv. p. 207), states, as a simple consequence of the earth's rotation, the deviation to the right bank of all rivers of the northern hemisphere running north and south, *i.e.* to the west, if the flow is from the north, and to the east if from the south. Considered from this point of view, it may suffice that the masses of ice are borne by currents from the north, to account for the accumulations on the western borders of these currents, *i.e.* on "the eastern coast of any portion of land." I am well aware that the principle in question was applied to the theory of ocean-currents, long ere C. E.

[1] Along this shore, seal, walrus, and the right whale abounded in 1846, 1847, and 1853, when I was there. In 1854 constant easterly winds kept the ice close to the land for ten days, so that few marine animals were seen during that time.

von Baer extended it to the phenomena of rivers; the above case may be considered as connecting together both classes of phenomena.

D. WETTERHAN

Freiburg-im-Breisgau, November 26

Spectrum of the Electric Light

WILL you, or one of your spectroscopical contributors, kindly inform me in what respects (if at all) the spectrum of the electric light differs from that of the sun? At a time apparently not far distant from the almost universal application of the electric light, the question I ask is not unimportant, as it, I believe, affects the tolerance of the human eye for other than solar light. It is already well known that much work done by gas-light is by many found prejudicial to their vision, and this may, I presume, be caused by the inherent qualities of the light. It will be interesting to me therefore to learn in what respects electric light and gas-light differ from solar, as shown by spectrum analysis.

J. HOPKINS WALTERS

Reading, November 28

A GLIMPSE THROUGH THE CORRIDORS OF TIME[1]

II.

AT the remote epoch of which we are speaking the solar tides were very small, as they are at present. Yet, small as they are, there was a particular circumstance which may have enormously increased their importance. The point to which I refer can be illustrated very simply. We have here a weight of 14 lbs. freely suspended, and here I have a small wooden mallet which barely weighs half an ounce, yet small as this mallet is, I can make the heavy weight swing by merely giving it blows with the mallet. Let me try. I give the weight blow after blow. I hit it as hard as I can, yet the weight hardly swings. I have not yet been successful. The art of succeeding is merely to time the blows properly; this I am now doing, and you see the weight swings in an arc which is steadily augmenting.

We therefore see that a succession of impulses, in themselves small, can yet produce a great effect when they are properly timed. In the present case the impulses should succeed each other at the same interval as this pendulum requires for one to and fro oscillation. The time therefore depends on the body struck, and not at all on the body which gives the impulses.

Just as this pendulum swings with a definite period so the vibrations of the primæval earth had a certain period appropriate to them. Suppose that the liquid primæval globe were pressed in on two quadrants and drawn out on the two others, and that the pressures were then released. The globe would attempt to regain its original form, but this it could not do at once, any more than the pendulum can at once regain its vertical position; the protruded portions would go in, but they would overshoot the mark, and the globe would thus oscillate to and fro. Now it has been shown that the period of such oscillations in our primitive globe is about an hour and a half, or very close to half the supposed length of the day at that time. The solar tides, however, also have a period half the length of the day. Here then we have a case precisely analogous to the 14 lb. weight I have just experimented on. We have a succession of small impulses given which are timed to harmonise with the natural vibrations. Just as the small-timed impulses raised a large vibration in the weight, so the small solar tides on the earth threw the earth into a large vibration. At first these vibrations were small, but at each succeeding impulse the amplitude was augmented until at length the cohesion of the molten matter could no longer resist: a separation took place: one portion consolidated to form our present earth; the other portion consolidated to form the moon.

There is no doubt whatever that the moon was once quite close to the earth; but we have to speculate as to what brought the moon into that position. I have given you what I believe to be the most reasonable explanation, and I commend it to your attention. There are difficulties about it, no doubt: let me glance at one of them.

I can easily imagine an objector to say, "If the moon were merely a fragment torn off, how can we conceive that it should have that beautiful globular form which we now see? Ought not the moon to have rugged corners and an irregular shape? and ought not the earth to show a frightful scar at the spot where so large a portion of its mass was rent off."

You must remember that in those early times the earth was not the rigid solid mass on which we now stand. The earth was then so hot as to be partially soft, if not actually molten. If then a fragment were detached from the earth, that fragment would be a soft yielding mass. Not for long would that fragment retain an irregular form; the mutual attraction of the particles would draw the mass together. By the same gentle ministrations the wound on the earth would soon be healed. In the lapse of time the earth would become as whole as ever, and at last it would not retain even a scar to testify to the mighty catastrophe.

I am quite sure that in so large and so cultivated an audience as that which I am now addressing, there are many persons who take a deep interest in the great science of geology. I believe however that the geologist who had studied all the text-books in existence might still be unacquainted with the very modern researches which I am attempting to set forth. Yet it seems to me that the geologists must quickly take heed of these researches. They have the most startling and important bearing on the prevailing creeds in geology. One of the principal creeds they absolutely demolish.

I suppose the most-read book that has ever been written on geology is Sir Charles Lyell's "Principles." The feature which characterises Lyell's work is expressed in the title of the book, "Modern Changes of the Earth and its Inhabitants considered as Illustrative of Geology." Lyell shows how the changes now going on in the earth have in course of time produced great effects. He points out triumphantly that there is no need of supposing mighty deluges and frightful earthquakes to account for the main facts of geology.

Lyell attempts to show that the present action of winds and storms, of rains and rivers, of ice and snow, of waves and tides, will account for the formation of strata, and that the gentle oscillations of the earth's crust will explain the varying distribution of land and water. In this we can to a great extent follow him. I am quite satisfied with the oscillations in the land. If the land rises an inch or two every century in one place and falls to the same extent elsewhere, all that is required has been explained. Nor do I feel at present disposed to question his views as to rivers or to glaciers, to rains or to winds. There is however one great natural agent of which Lyell does not take adequate account. He does not attach enough importance to the tides. No doubt he admits that the tides do some geological work. He even thinks they can do a great deal of work. The sea batters the cliffs on the coasts, and wears them into sand and pebbles. The glaciers grind down the mountains, the rains and frosts wear the land into mud, and rivers carry that mud into the sea. In the calm depths of ocean this mud subsides to the bottom; it becomes consolidated into rocks; in the course of time these rocks again become raised, to form the dry land with which we are acquainted.

The tides, says Lyell, help in this work. Tidal currents aid in carrying the mud out to sea; they aid to a considerable extent in the actual work of degradation, and

[1] Lecture delivered at the Midland Institute, Birmingham, on October 24, 1881, by Prof. Robert S. Ball, LL.D., F.R.S., Andrews Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland. Contributed by the Author. Continued from p. 82.

thus contribute their quota to the manufacture of stratified rocks. Such is the modest *rôle* which Lyell has assigned to the tides, and no doubt the majority of geologists have acquiesced in this doctrine. Nor can there be any doubt that this is a just view of tidal action at present. That it is a just view of tidal action in past times is what I now deny. Lyell did not know—Lyell could not have known—that our tides are but the feeble surviving ripples of mighty tides with which our oceans once pulsated. Introduce these mighty tides among our geological agents, and see how waves and storms, rivers and glaciers, will hide their diminished heads.

I must attempt to illustrate this view of tidal importance in ancient geological times. Let me try by the aid of the tides to explain the great difficulty which every one must have felt in regard to Lyell's theory. I allude to the stupendous thickness of the Palæozoic rocks.

Look back through the Corridors of Time in the manner in which they are presented to us in the successive epochs of geology. We pass rapidly over the brief career of prehistoric man; then through the long ages of Tertiary rocks, when the great mammals were developed; back again to the much earlier period when colossal reptiles and birds were the chief inhabitants of the earth; back again to those still earlier ages when the luxuriant forests flourished that have given birth to the coal-fields; back once more to the age of fishes; back finally to those earliest periods when the lowest forms of life began to dawn in the Palæozoic era.

As we date remote ages astronomically by the distance of the moon, so we date remote ages geologically by the prevailing organic life. It is a great desideratum to harmonise these two chronological systems, and to find out, if possible, what lunar distance corresponds to each geological epoch. In the whole field of natural science there is no more noble problem. Take, for example, that earliest and most interesting epoch when life perhaps commenced on the earth, and when stratified rocks were deposited five or ten miles thick, which seem to have contained no living forms higher than the humble Eozoon, if even that were an organised being. Let us ask what the distance of the moon was at the time when those stupendous beds of sediment were deposited in the primæval ocean. We have in this comparison every element of uncertainty except one. The exception is, however, all important. We know that the moon must have been nearer to the earth than it is at present. There are many very weighty reasons for supposing that the moon must have been very much nearer than it is now. It is not at all unlikely that the moon may then have been situated at only a small fraction of its present distance. My argument is only modified, but not destroyed, whatever fraction we may take. We must take some estimate for the purpose of illustration. I have had considerable doubts what estimate to adopt. I am desirous of making my argument strong enough, but I do not want to make it seem exaggerated. At present the moon is 240,000 miles away; but there was a time when the moon was only one-sixth part of this, or say 40,000 miles away. That time must have corresponded to some geological epoch. It may have been earlier than the time when the Eozoon lived. It is more likely to have been later. I want to point out that when the moon was only 40,000 miles away, we had in it a geological engine of transcendent power.

On the primitive oceans the moon raised tides as it does at present; but the 40,000-mile moon was a far more efficient tide-producer than our 240,000-mile moon. The nearer the moon the greater the tide. To express the relation accurately we say that the efficiency of the moon in producing tides varies inversely as the cube of its distance. Here then we have the means of calculating the tidal efficiency for any moon distance. The 40,000-mile moon being at a distance of only one sixth of our present moon's distance, its tidal efficiency would be increased $6 \times 6 \times 6$ fold. In other words, when our moon was only 40,000 miles away it was 216 times as good a tide-producer as it is at present.

The heights to which the tides rise and fall is so profoundly modified by the coasts and by the depth of the sea, that at present we find at different localities tides of only a few inches and tides of 60 or 70 feet. In ancient times there were no doubt also great varieties in the tidal heights, owing to local circumstances. To continue our calculation we must take some present tide. Let us discard the extremes just indicated and take a moderate tide of 3-feet rise and 3-feet fall as a type of our present tides. On this supposition what is to be a typical example of a tide raised by the 40,000 mile moon? If the present tides be 3 feet, and if the early tides be 216 times their present amount, then it is plain that the ancient tides must have been 648 feet.

There can be no doubt that in ancient times tides of this amount and even tides very much larger must have occurred. I ask the geologists to take account of these facts, and to consider the effect—a tidal rise and fall of 648 feet twice every day. Dwell for one moment on the sublime spectacle of a tide of 648 feet high, and see what an agent it would be for the performance of geological work! We are now standing, I suppose, some 500 feet above the level of the sea. The sea is a good many miles from Birmingham, yet if the rise and fall at the coasts were 648 feet, Birmingham might be as great a seaport as Liverpool. Three-quarters tide would bring the sea into the streets of Birmingham. At high tide there would be about 150 feet of blue water over our heads. Every house would be covered, and the tops of a few chimneys would alone indicate the site of the town.

In a few hours more the whole of this vast flood would have retreated. Not only would it leave England high and dry, but probably the Straits of Dover would be drained, and perhaps even Ireland would in a literal sense become a member of the United Kingdom. A few hours pass, and the whole of England is again inundated, but only again to be abandoned.

These mighty tides are the gift which astronomers have now made to the working machinery of the geologist. They constitute an engine of terrific power to aid in the great work of geology. What would the puny efforts of water in other ways accomplish when compared with these majestic tides and the great currents they produce?

In the great primæval tides will probably be found the explanation of what has long been a reproach to geology. The early palæozoic rocks form a stupendous mass of ocean-made beds which, according to Prof. Williamson, are twenty miles thick up to the top of the silurian beds. It has long been a difficulty to conceive how such a gigantic quantity of material could have been ground up and deposited at the bottom of the sea. The geologists said, "The rivers and other agents of the present day will do it if you give them time enough." But unfortunately the mathematicians and the natural philosophers would not give them time enough, and they ordered the geologists to "hurry up their phenomena." The mathematicians had other reasons for believing that the earth could not have been so old as the geologists demanded. Now, however, the mathematicians have discovered the new and stupendous tidal grinding-engine. With this powerful aid the geologists can get through their work in a reasonable period of time, and the geologists and the mathematicians may be reconciled.

I have here a large globe to represent the earth, and a small globe suspended by a string to represent the moon. At the commencement of the history the two globes were quite close; they were revolving rapidly, and the moon was constantly over the same locality on the primæval earth. I do not know where that locality was; it was probably the part of the earth from which the moon had

been detached. No doubt it was somewhere near the equator, but the distinction of land and water had not then arisen. Around the primæval earth the moon revolved in three hours; the earth also revolved in three hours, so that the moon constantly remained over the red region. This I can illustrate by holding the small globe which represents the moon in one hand, and making the large globe which represents the earth revolve by the other.

This state of things formed what is known as unstable dynamical equilibrium. It could not last. Either the moon must fall back again on the earth, and be reabsorbed into its mass, or the moon must commence to move away from the earth. Which of these two courses was the moon to take? The case is analogous to that of a needle balanced on its point. The needle must fall some way, but what is to decide whether it shall fall to the right or to the left? I do not know what decided the moon, but what the decision was is perfectly plain. The fact that the moon exists shows that it did not return to the earth, but that the moon adopted the other course, and commenced its outward journey.

As the moon recedes, the period which it requires for a journey round the earth increases also. Initially that period was but three hours, and it has increased up until our present month of 656 hours.

The rotation of the earth has been modified by the retreat of the moon. Directly the moon began to retreat the earth was no longer under an obligation to keep the same face thereto. When the moon was at a certain distance the earth made two rotations for every revolution that the moon made. Thus as I carry the small globe round the large globe the latter makes two revolutions for one revolution of the small globe. Still the moon gets further and further away, until the earth performs three, four, or more rotations for each of the moon's revolutions. Do not infer that the rate of the earth's rotation is increasing; the contrary is the fact. The earth's rotation is getting slower, and so is that of the moon; but the retardation of the moon is much greater than that of the earth. Even though the rotation of the earth is much more than the primitive three hours, yet that of the moon has increased to several times the rotation of the earth.

The moon recedes still further and further, and at length a noticeable epoch is reached, to which I must call attention. At that epoch the moon is so far out that its revolution takes twenty-nine times as long as the rotation of the earth. The month was then twenty-nine times the day. The duration of the day was less than the present twenty-four hours, but I do not believe it was very much less. The time we are speaking of is not very remote, perhaps only a very few million years ago. The month was then in the zenith of its glory. The month was never twenty-nine times as long as the day before. It has never been twenty-nine times as long as the day since. It will never be twenty-nine times as long as the day again.

Resuming our history, we find the moon still continuing to revolve in an ever-widening circle the length of the month and of the day both increasing. The ratio of the day to the month was still undergoing a change. When the moon was a little further off the earth only revolved twenty-eight times instead of twenty-nine times in one revolution of the moon. Still the velocity of the earth abates until it only makes twenty-seven revolutions in one revolution of the moon. This is an epoch of especial interest, for it is the present time. In the present order of things the moon revolves round the earth once while the earth rotates twenty-seven times. This has remained sensibly true for thousands of years, and no doubt will remain sensibly true for thousands of years to come, but it will not remain true indefinitely. Wondrous as are the changes which have occurred in times past, not less wondrous are the changes which are to occur in time to come. The tides have guided our gropings into the past; they will continue to guide our researches to make a forecast of the future.

Further and further will the moon retreat, and more and more slowly will the earth revolve. But we shall not pause at intervening stages; we shall try to sketch the ultimate type to which our system tends. In the dim future, many millions of years distant, the final stage will be approached. As this stage draws nigh, the rotation of the earth will again approach to equality with the revolution of the moon. From the present month of twenty-seven days we shall pass to a month of twenty-six days, of twenty-five days, and so on, until eventually we shall reach a month of two days, and lastly a month of one day. When this state has been attained the earth will constantly turn the same region towards the moon. I do not know what is the locality on the earth which is destined for this distinction.

Here you see that the first state and the last state of the earth-moon history are in one sense identical. In each case the same face of the earth is constantly directed towards the moon. In another way, how different are the first stage and the last. At the beginning the day and the month were both equal, and they were each three hours. At the end the day and the month will be again equal, but they will each be 1400 hours. The moon will then go round the earth in 1400 hours, while the earth will rotate on its axis in the same time. In other words, the day is destined in the very remote future to become as long as fifty-seven of our days. This epoch will assuredly come if the universe lasts long enough. When it has come it will endure for countless ages. It would endure for ever if the earth and the moon could be isolated from all external interference.

We heard a great deal a few years ago about the necessity of shortening the hours of labour. I wish to point out that the social reformers who are striving to shorten the hours of labour are pulling one way, while the moon is pulling the other. The moon is increasing the length of the day. The change will be very gradual, but none the less is it inevitable. Where will the nine-hours' movement be when the day has increased to 1400 hours? This will be a very serious matter, and there is only one way by which it can be avoided. The question is one rather for engineers than for astronomers; but I cannot help throwing out a suggestion. My advice is: Anchor the moon, and keep it from going out. If you can do this, and if you can also provide a brake by which the speed of the moon can be controlled, then you will be able for ever to revel in the enjoyment of a twenty-four-hour day.

Should this engineering feat never be accomplished, then we have only the 1400-hour day to look forward to. Nor is there anything untoward in the prospect, when we take natural selection as our comforter. By natural selection man has become exactly harmonised with his present environment. No doubt natural selection moves at a dignified pace, but so in all truth does tidal evolution. Natural selection and tidal evolution have advanced *pari passu* through all the past millions of geological time. They will advance *pari passu* through all the ages yet to come. As the day lengthens, so will man's nature gradually change too, without any hardship or inconvenience. All that is necessary is plenty of time. Should we think it a hardship that our children should have a day of twenty-four hours and one second instead of twenty-four hours? That the day enjoyed by our grandchildren should be a second longer than the day of our children? That the day of our great-grandchildren should be a second longer still, and so on continually? This would be no inconvenience whatever. No one except the astronomers would be able to detect the change, and daily life would be unaltered. Yet, carry on this process for only 150 million years, and we shall find that the whole change of the day from

twenty-four hours to 1400 hours has been accomplished. The actual rate of change is indeed much less than this, and is at present so small that astronomers can hardly even detect it.

Our remote posterity will have a night 700 hours long, and when the sun rises in the morning 700 hours more will elapse before he can set. This they will find a most suitable and agreeable arrangement. They will look back on our short periods of rest and short periods of work with mingled curiosity and pity. Perhaps they will even have exhibitions of eccentric individuals able to sleep for eight hours, work for eight hours, and play for eight hours. They will look on such curiosities in the same way as we look on the man who undertakes to walk a thousand miles in a thousand hours.

I am beyond all things anxious to give you the impression that I am not indulging in any mere romance. No doubt the various figures I have mentioned are but estimates. They may be found to require correction—perhaps large correction; but the general outline of the theory must be true. Should any traces of doubt still linger in the mind of some prejudiced person, let me finally dissipate them. Perhaps some caviller may say, Where are the proofs of all this action of the tides? How do you know that the tides are sufficiently powerful to produce such changes? I believe I have shown this abundantly, but some people require a great deal of conviction. I have therefore kept my best argument for the end.

For an overwhelming proof of tidal efficiency I shall summon the heavens themselves to witness, and I shall point to the stupendous task which tides have already accomplished. As the moon has made and is making tides on the earth, so the earth once raised tides on the moon. These tides have ceased for ages; their work is done; but they have raised a monument in the moon to testify to the tidal sufferings which the moon has undergone. To that monument I now confidently appeal. The moon being much smaller than the earth, the tides on the moon produced by the earth must have been many times as great as the tides on our earth produced by the moon. It matters not that the moon now contains no liquid ocean. Nor does it matter whether the moon ever had a liquid ocean. In very ancient days the moon was not the hard, rigid mass which it now appears. Time was when the volcanoes raged on the moon with a fury which nothing on our earth at present can parallel. The moon was then in a soft or a more or less fluid condition, and in this viscous mass the earth produced great tides.

Great tides in truth they were, for the earth is eighty times as heavy as the moon. On the other hand, the moon is only one-fourth the diameter of the earth; so that the actual height of the tides on the moon would be still many times as great as the tides on the earth. When the moon was nearer to us, as it was in early ages, those tides were still greater. Think for one moment of what a lunar tidal wave of such magnitude would be capable. This wave is perhaps of molten lava; it would tear over the surface with terrific power, and anything that friction could accomplish that great current would do. That tidal current has done its work; even if the moon were fluid at the present day it could no longer be distracted by tides. Remember, it is not the mere presence of the tide which produces friction. It is the action of the tide in rising and in falling which accomplishes the work. If, therefore, the moon moved so that it was always high tide at the same place, the tides could produce no further effect. The spot where the tide is high on the moon is the spot which is towards the earth. It hence follows that the action of the tides will cease when the moon constantly directs the same face to the earth. The moon has thus at length gained a haven of rest from a tidal point of view. No doubt the moon has a high tide and it has a low tide, but those tides no longer ebb and flow: the moon has succumbed to the incessant action of friction, and has assumed the only attitude which can relieve it from incessant disturbance.

For many centuries it had been an enigma to astronomers why the moon should always turn the same face to the earth. It could be shown that there were many million chances to one in favour of this being due to some physical cause. The ordinary theory of gravitation failed to explain the cause. Every one had noticed this phenomenon. Yet the explanation was never given till lately. It was Helmholtz who showed that this was a consequence of ancient tides, and this simple and most satisfactory explanation has been universally accepted. The constant face of the moon is a living testimony to the power of the tides. What tides have accomplished on the moon is an earnest of what tides will accomplish on the earth.

In the great conflict of the tides the earth has already conquered the moon, and forced the moon to render perpetual homage as a token of submission. Remember, however, that the earth is large, and the moon is small. Yet small though the moon is, it gallantly struggles on. "You have forced me," cries the moon to the earth, "to abandon the rotation with which I was originally endowed; you have compelled me to rotate in the manner you have dictated. I will have my revenge. It is true I am weak, but I am unrelenting; day by day I am exhausting you by the tides with which I make you throb. The time will assuredly come, though it may not be for millions of years, when you shall be forced to make a compromise. When that compromise is made the turmoils of the tides will cease; our mutual movements will be adjusted. With equal dignity we shall each rotate around the other; with equal dignity we shall each constantly bend the same face to the other."

There is another point to be considered. We must not forget that there is a sun in the heavens as well as a moon. The sun also produces tides in the earth. Those tides were much smaller than the lunar tides, so that we could afford to neglect them. But we have seen that the lunar tides will gradually decrease to nothing. It behoves us then to consider what the solar tides can effect which shall be worthy of our attention. In a lecture which I gave here some years ago, I made allusion to the discovery of the satellites of Mars. I mentioned that one of the satellites of Mars presented a phenomenon unparalleled in the solar system. The satellite revolved around Mars in a period of seven hours, while Mars himself rotated on his axis in a period of twenty-four hours. We here actually find the moon of Mars rotating around Mars in much less than one of Mars' own days. This was a most curious and unexpected circumstance, but the observations of the discoverer, Asaph Hall, placed the great fact beyond any doubt. The mystery has now been explained. It is due to the action of the solar tides on Mars. Nay more, we can actually foresee that at some incredibly remote future time our earth and moon are destined to present the same movements which have seemed so anomalous in Mars.

Left to themselves, the earth and the moon would have remained for ever in the condition of compromise. The moon would have revolved round the earth in 1400 hours. The earth would have rotated on its axis in 1400 hours also. But now the solar tides intervene. They have little effect upon the moon; it revolves as before, but the solar tides begin to retard the earth still further. Instead of a period of 1400 hours, the earth will have a still longer day, so that finally the moon revolves more rapidly around the earth than the earth rotates on its axis.

It seems to me that the episode I have mentioned is one of the most interesting in the whole of modern astronomy. We have first a most delicate telescopic discovery of the tiny satellite of Mars and of its anomalous movements. We then have a beautiful explanation of how

this anomalous motion has arisen from the action of solar tides. Finally we have in this miniature system of Mars a foreshadowing of the ultimate destiny of our earth and our moon.

Do I say the ultimate destiny? Nothing is ultimate in nature. The moon and the earth would have come to an amicable and a final agreement had they been let alone. But now the sun has intervened and disturbed the earth's rotation. The truce once broken, the moon again produces tides on the earth, the earth reacts on the moon, and a whole chain of complicated movements are the consequence. I shall not now attempt to trace the further progress of events.

I have dealt with very large figures in this lecture, and perhaps I have taxed your imagination by my demands that you should conceive of periods of tens of millions of years. Yet after all let us look at the results in their true proportion, compared with the universe in which our lot has been cast.

Truly we have been engaged with a very trifling matter. Is not our earth one of the most insignificant bodies in the universe? And our moon is much smaller still. Nor is it even the life-history of our earth that we have been considering, it is merely a brief episode in that history. What are the periods of time we have been discussing when compared with those infinitely longer periods during which the solar system has been evolved? Even the solar system is but one out of one hundred million such systems, each of which has its own life-history. Viewed in their true proportions, the phenomena I have described are but of infinitesimal importance, and the time they have occupied is merely ephemeral.

No doubt we have only dwelt upon the tides on the earth and the tides in the moon, which have been of such infinite importance. But do not suppose that tides are confined to the earth and to the moon. So far as we know, every body in the universe is capable of producing, and actually does produce, tides in every other body. Every planet throbs in response to the tides produced in it by every other planet. Every star has a distinct tidal wave produced in it by every other star. You may say that such tides are infinitesimal, but you must remember that infinitesimal causes, sufficiently often repeated, can achieve the mightiest effects.

We know that tides have wrought our solar system into its present form; and are we to say that the wondrous powers of the tide have no grander scope for their exercise? I prefer to believe that tides operate far and wide through the universe, and that in the recognition of the supreme importance of tidal evolution we mark a great epoch in the history of physical astronomy.

POPULAR NATURAL HISTORY[1]

THE present volume of this finely illustrated work finishes the account of the Vertebrates with the history of the Fishes, and gets over as well an immense mass of the Invertebrates. The story of the Fishes is contributed by Prof. H. G. Seeley, who, in the limited compass of 150 pages, of which about one-sixth is occupied with figures, has given a very fair and comprehensive notice of this class. The Fishes are the only primary division of the Vertebrata which live in water, and have no representatives passing their lives upon land or in the air. This condition of existence is probably the cause of the close correspondence in bodily form in the majority of fishes, which progress through the water chiefly by movements of the tail, and use the fins as organs with which to steer a path. "Clear as is the idea which rises in the mind at the mention of a fish, the multitude of forms which fishes exhibit are greater, perhaps, than those to be found in any of the other great groups of Vertebrate animals described in the previous four volumes of this series. The slender form of the lamprey or eel contrasts with the expanded body of the turbot or the plaice; the short deep form of the sun-fish is unlike the broad, flattened, and long-tailed skate; the sea-horses, when attached to sea-weeds by their prehensile tails, at first sight present none of the familiar characteristics of fishes. The flying-fish, which have the fins so expanded as to serve some of the purposes of wings, present a remarkable contrast to the spheroidal spiny body of the globe-fish, while the hammer-headed shark exhibits a form of body in some respects more singular still. When we turn to details of proportion and structure, and contrast the shapes of the head or of the tail, the variety among fishes is altogether exuberant."

As an illustration of the woodcuts to be found plentifully in this volume, we select a sea-horse some time since described by Dr. Günther, the strange *bizarre* form of which will at once attract attention. The illustration is a very fair copy of the beautifully-drawn figure of Mr. Ford in the *Proceedings* of the Zoological Society of London for 1865, and represents, of the natural size, a specimen of *Phyllopteryx eques* from South Australia. "There is no doubt," writes Dr. Günther, "that these fish attach themselves with the prehensile end of their tails to stems of sea-weed and other objects; and when they are in the vicinity of sea-weed of a similar colour to themselves, their resemblance to it must be so great that they would easily escape being observed by their enemies." We fancy that Prof. Seeley is wrong in stating that, "as the name implies, this fish has very much the aspect of a moving plant." The idea in Swainson's mind was doubtless nearer to the actual meaning of the words he formed the generic title from—that of leaf-winged—and we may venture to call Dr. Günther's species the Leaf-finned Sea-horse.

The section on Fossil Fishes is very short, but a great deal of information is contained therein. "A large proportion of fossil fishes belong to the division Palæichthyes. This group comprises most of the fishes which have been met with in the primary rocks and many of those found in the Secondary strata; but in Tertiary deposits the Teleostean division is quite as well represented in the geological formations as in existing seas. There is no evidence of any gradual succession of fishes in the order of increased complicity of structure, as the deposits in which they occur approach nearer to the present day, and there is no reason to suppose that the oldest fishes known were the first that appeared upon the earth. The earliest fishes discovered were met with in the Lower Ludlow rocks, which form the upper part of the Silurian strata. The most ancient genus is Scaphaspis, a small buckler-headed fish, which had the body covered with scales. Many allied genera are found in the overlying Old Red Sandstone, in which fishes appear in extraordinary variety. Among the allies of Scaphaspis are Pteraspis, Cephalaspis, &c., some of which range down to the Silurian rocks. Near to these fishes must be placed Coccosteus, Pterichthys, and the immense American fossil of Devonian age named Dinichthys. These fishes are thought to be related to Ganoids and Sharks, but in external form they more closely approximate to Loricaria, though the tail is heterocercal. They form a distinct group named Placodermi."

While four volumes and a goodly portion of a fifth are devoted to the Vertebrata, there are not wanting signs that the immense divisions of the animal kingdom here grouped as Invertebrata are to be treated of after the usual stereotyped fashion, and that at most one further volume will bring this series to a close. The Invertebrata, we are told, are divided into great types, or groups, which are (1) the Mollusca; (2) the Arthropoda; (3) the Vermes; (4) the Echinodermata; (5) the Zoophyta; and (6) Protozoa. "These great divisions are not exactly

[1] "Cassell's Natural History." Edited by P. Martin Duncan, M.B., F.R.S. Vol. v., illustrated. (London: Cassell, Petter, Galpin, and Co., 1881.

defined in nature, and they are subdivided into secondary groups, and are also united in some instances by forms of life which cannot well be placed in any particular one." We presume these "latter forms of life" are those called "intermediate groups," which are "(1) the Tunicata, which have a more or less leathery or cartilaginous covering sac." "They may be placed in the neighbourhood of the Vermes and Mollusca in their classification." "(2) The Molluscoida, which have the body with shells placed differently to those of the Mollusca, or have a tubular or shell-like covering." "The Bryozoa and Brachiopoda are included in this group, and in their structures, embryonic and adult, they show resemblances to those of Vermes, Mollusca, and Tunicata."

The chapters on Mollusca and Tunicata are by Dr. Henry Woodward; the Bryozoa and Brachiopoda by Agnes Crane; the introduction to Insecta and the account of the order of the Hymenoptera is from the pen of Mr. Dallas, and the chapter on the order of Coleoptera is by Mr. Bates. In passing we may note that the reader will find no hint that the Arthropods are jointed-limbed animals containing the Crustacea and Arachnids, unless incidentally when Mr. Dallas is describing the true Insect type.

It is scarcely necessary to state that within the limits at his disposal Dr. H. Woodward has given a very interesting account of the Molluscan forms. We are glad to note too that he has devoted a good portion of his space to an account of the Cuttle-fishes, which is more exciting and interesting reading than the necessarily brief accounts of such families as those of Cancellariadæ and Pyramidellidæ. The chapter on that "intermediate type," the Tunicata, is poor indeed, and not what we should have expected from its author. Surely we have

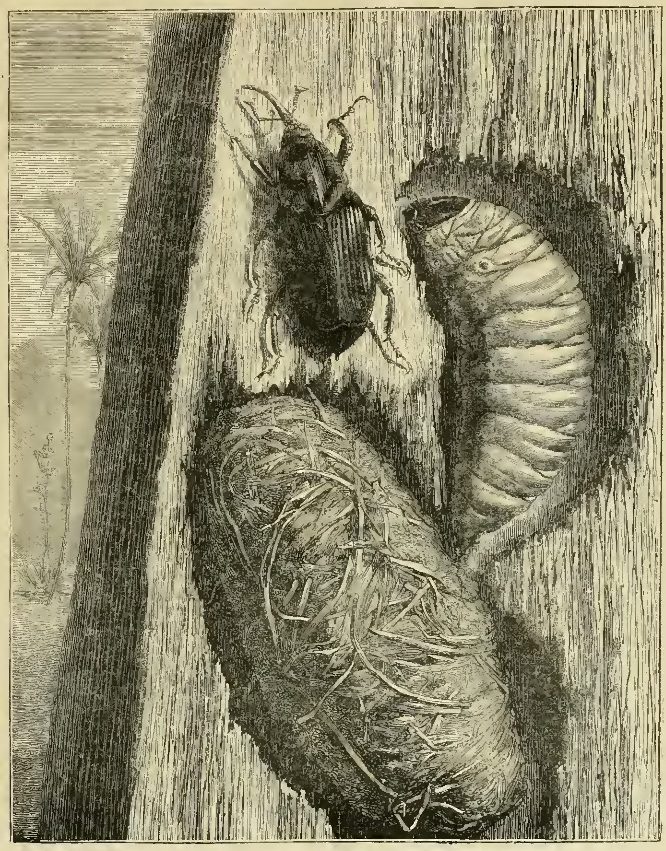
The Leaf-finned Sea-horse.

learned something more of this group since the writings of Forbes and Savigny.

The chapters on the Brachiopoda and Bryozoa by Agnes Crane appear to be extremely carefully written. The illustrations—many of them—are refreshingly new, and taken from the best of sources. We altogether disagree with the authoress as to adopting the name of Bryozoa for the group she calls Sea-mosses, but she states the case for and against the use of the term Polyzoa most fairly; and nowhere have we met a more neatly compiled account, brought down, too, to the very latest date of this group—even the facts brought to light by the expedition of the *Challenger* are alluded to therein.

The introduction to the group of Insects is remarkably well done. The classification is primarily based on the presence or absence of a perfect metamorphosis, and the secondary divisions are based on the structure of the mouth. As for certain small groups of insects which undergo no metamorphosis at all, "They may be residues of groups formerly more numerous and abundant, in which case they ought probably to be kept distinct from the other existing orders of Insects," or as we prefer to think, "they may be degraded representatives of the orders to which they appear to be most nearly related." The account of the first order on the list, that of the Beetles, is written by H. W. Bates, and few possess more knowledge of the many forms that compose this group. It need not be said that he does not attempt to treat of the 80,000 and upwards of known forms in the fifty pages at his service, but from what he tells us of the habits of those he does describe, we feel our interest in the subject increasing, until, when we come to the account of the Ladybirds, "upwards of 1500 species of which are known," we feel sorry that we have come to the very last line long ere the author had evidently come to the last of his subject.

We give, through the courtesy of the publishers, another illustration taken from the chapter on Weevils. It is of a weevil known as *Rhyncophorus palmarum*. Its fat grubs live on the stems of palm-trees, and are often very destructive. Several of the species are very injurious to the sugar-cane. One found in sugar-plantations in Guiana contain in their intestines lumps of a sweet waxy substance—the altered saccharine food on which they live—and for this they are boiled and eaten by the natives. The fine fat larva and the pupal condition, as well as the full-grown weevil, are to be seen in the engraving.



The Palm Weevil.

The account of the immense and important order of the Hymenoptera is written by Mr. Dallas; but only the history of the Aculeata is here given, and the other sections are reserved until the succeeding volume.

AMI BOUÉ

THE decade which closes this year will remain a memorable one in the annals of geology for the great names which appear in its obituary. Not a few of the early leaders, to whom it was possible to master fully every department of the infant science and to strike out into new untrodden paths in almost any direction, have lived on to witness the vast development of the studies which they did so much to foster. In this country we have lost only lately Murchison, Sedgwick, Lyell, Phillips, Scrope, whom we early learnt to reverence as demi-gods of the heroic age. And now to these names another falls to be added which, though not that of a Briton, has long been a household word among the geologists of this country. The veteran Ami Boué has just passed away. Ripe in years and universally honoured, he has remained perched on his beloved mountain slopes like a boulder stranded above the reach of the all-devouring sea. But the tide of mortality has at last swept him away, and has thus broken one of the most interesting ties that bound us to the early days of geology. Having for many years enjoyed

the privilege of his friendship and having heard from his own lips many of the incidents of his life, I am able to give here a few personal reminiscences which may be of general interest at the present time, without at present attempting to offer any summary or review of the scientific work of his life. It is much to be desired that his own notices of his life should be published. His early wandering years were especially eventful, and their history is intimately bound up with that of the science which he cultivated with so much ardour.

Ami Boué was born, so far as I can make out, on March 16, 1794, so that he had reached the eighty-eighth year of his age. He was descended of an old French family, and could trace his pedigree back for some four centuries. In the time of Louis XIV., when so large a part of the Protestant population fled on the Revocation of the Edict of Nantes, his ancestor escaped from Bordeaux in a barrel. The family went first to Amsterdam, and finally settled at Hamburg. His mother's family belonged to an Alsatian stock, by name Roth-Hut, which, when they came to Geneva, was changed into Chapeaurouge. She was the daughter of a rich merchant who had established himself at Hamburg, but she was sent at an early age to her relatives in Geneva. Hence French became her early, and to the end of life her natural, language, for though she returned to Hamburg and married there, she never acquired fluency in German, and French was the language in which she always talked to her children. Thus, though born in Hamburgh, Boué spoke and wrote French, and not German, as the language of his boyhood. Both his father and mother appear to have died when he was still very young. He was accordingly sent to the care of his uncles in Geneva to be educated. It was intended that he should enter the mercantile life, in which most of his relatives were engaged. But at that time the French were menacing Hamburg, and the state of Europe was so unquiet that his guardians, deeming him safer in Geneva, kept him there studying jurisprudence. His tastes were already, however, strongly turned towards natural science, and he threw himself heartily into the pursuit of mineralogy and botany. He was accordingly allowed to prosecute these studies, in which he made considerable progress. The political horizon continuing still ominously dark, Boué's future was somewhat uncertain. There was family property enough in Hamburg to secure a small competence for himself and his brothers; but it consisted of property and stock which might be destroyed by the French, as had happened already to one of his uncles. So his guardians determined that he ought to have some profession to fall back upon in case of the destruction of the Hamburg property. He chose medicine as the career that promised most facilities for prosecuting natural history studies. Britain offering at that time the only safe retreat for him, he was sent to the medical school of Edinburgh University. As he used to say himself, "I really went to Scotland to escape from Napoleon." Coming with good introductions from Prevost of Geneva and others to Dugald Stewart and other eminent men, he found a welcome in the most cultivated society of Edinburgh. For three months he employed himself principally in acquiring English, which he eventually mastered sufficiently to be able to read it fluently, and with less success to speak and write it. To the end of his long life he was glad of every opportunity of using his knowledge of English. His letters to me were always in English, closely written, without spectacles, in an almost microscopic handwriting, and not seldom sealed with a thistle and "Dinna forget," which he cherished as one of the souvenirs of his student days in Scotland. He studied chemistry under Hope, and took voluminous notes in French, which he had carefully preserved. He knew more botany, he used to say, than his professor, and profited nothing by that class. But the natural history class under Jameson greatly stimulated his mineralogical and geological zeal. In the fortnight between the winter and summer sessions he would always rush off for an excursion into some part of the country with hammer, bag, or vasculum. The long autumn vacation, too, was put to a similar use. In this way he made himself personally familiar with much of the Scottish Highlands, including Mull and Arran. He extended his rambles into the basaltic tracts of the north of Ireland, and visited also the Lake District and part of Derbyshire. Besides receiving the friendly assistance of his teacher, Jameson, he was intimate with Playfair, and accompanied MacCulloch in his yacht round Arran.

Meanwhile events of worldwide importance and of the utmost interest to Boué had been rapidly passing on the Continent. The final disaster at Waterloo, by shattering Napoleon's power, had freed Boué's Hamburg property from all risk of attack, and left him at liberty regarding his future career. He resolved to complete his medical education, and accordingly took his degree at Edinburgh in 1816. During the course of his medical work he had made many researches and experiments with the view of offering as his graduation thesis a treatise, *De Urina*. But finding he could not afford to publish so voluminous a mass of materials as he had collected, he chose another subject to which he had likewise given much attention—the causes of the present geographical distribution of plants. He was at that time much impressed by the writings of Humboldt on kindred topics, and in the course of his rambles over Scotland he had been in the habit of noting carefully the relations between the flora of each district and its geological structure. Accordingly he duly presented to the Senatus a Latin thesis, "De Methodo Floram regionis cujusdam conducendi, exemplis e florâ Scoticâ &c., ductis, illustrata." It was characteristically and gratefully dedicated to his maternal uncles and guardians.

Having graduated as a doctor of medicine at Edinburgh, he left Scotland immediately thereafter, and went to Paris to prosecute his studies in physics and chemistry. While thus engaged he brought together the large collection of notes he had made in Scottish geology, and elaborated them into his well-known "Essai Géologique sur l'Écosse" a work which will always rank as one of the early classics of the science. Unfortunately for the book he left Paris on his travels before it had passed through the press. He placed the revision of the proofs in the hands of a friend, and hence many errors crept both into the text and the plates.

Being now free to move about as he chose, he devoted himself with all the ardour of his enthusiastic nature to the prosecution of geology. He personally visited most of the more interesting tracts of France and Central Europe, but finally devoted himself to the eastern regions, as being those about which least was known. At the age of thirty-two he married a lady six years younger than himself, who accompanied him in many of his journeys, and who now survives him. The best evidence of his constant industry is furnished by the list of papers and memoirs, some 200 in number, which during his long life he published in the scientific journals of Europe. Some of his best work was done in Turkey, of which country indeed he was the first great geological explorer. The volumes in which he embodied the results of his researches there show at once his skill as an observer and the quiet indomitable courage with which he must have faced every kind of privation and even danger. On one occasion, as he told me, he was poisoned by his servant—a nobleman, who leaving him for dead, made off with the carriage and everything belonging to the poor traveller except his watch, which, being only of silver, was not considered worth stealing.

After some years spent in field-work he published at Paris (1835) his excellent "Guide du Géologue-Voyageur,"

in which he gives the sum of his own practical experience, with a digest of what had been done by others. Though much of these two little pocket volumes has been superseded by the progress of science, they remain as an admirable summary of the geology of their time, while many of their sound practical directions may be usefully read and remembered in all time coming. The closing sentences of the preface may be quoted here for their personal reference. "Thrown from my earliest days on the highways of the world, as most of my kin have been, having spent my life among seven capitals of Europe, and having near relatives in a dozen cities of the north-west and centre of this continent, my travelling disposition may be easily understood, and my irresistible tendency to a vagabond life. I was left an orphan at eleven years, and became entirely master of my own movements at twenty. This want of a fixed residence, this facility of moving about and making myself at home everywhere, adopting the customs and language of each country, must naturally have taught me to travel, and may to some extent excuse my pretension to say more on these matters than others. I have traversed a good part of Europe, and have been able to examine in detail all the formations of this continent. In spite of trying adventures, it is no mere invalid who now speaks and bids adieu to an active life, but one who, having seen much during a period of twenty years, believes that he may usefully recapitulate his observations for the benefit of his fellows, before again starting on the wandering life to which fate seems to have condemned him. The West flees from me, the East summons me; my grave shall be where heaven may please." During one of his sojourns in Paris he and a few others founded the present distinguished Geological Society of France. In a letter which I had from him at the time of the jubilee of the Society last year, he writes: "The Geological Society of France was created in my library room, April 1, 1830; present were Brongniart (Alex.), Cordier, Férussac, Blainville, Constant Prevost, Jobert—all dead. [This is not quite correctly remembered; for the meeting took place on March 17, 1830, in the rooms of the Philomathic Society of Paris, Boué himself in the chair.] They wish I should preside at this solemn meeting, but at eighty-six years of age, with my infirmities, it was impossible." He was one of the early presidents of the Society, and through life continued to take a paternal interest in its welfare.

Some forty years ago or more, after many wanderings in Austria and the adjacent countries, Boué obtained a piece of land at Vöslau, on the last spurs of the Eastern Alps, looking over the great plain which stretches eastwards to the Carpathian mountains. There were at the time few or no houses about the place, and the three or four acres acquired by Boué were a free gift from the proprietor to encourage building there. Now it is a fashionable watering-place for the Viennese, with numerous villas and hotels gathered round a copious hot spring, the water from which is caught in a swimming basin. I visited the veteran there in 1869, and found him established for the summer among his vineyards and his orchard well stocked with quinces, almonds, peaches, and apples. He had no children, but had adopted as a daughter a relative of his wife. It was charming to see the enthusiasm with which he threw himself into everything that he did. In spite of severe suffering and numerous operations of lithotomy he still retained, for an old man of seventy-five, an extraordinary vigour and vivacity. He made wine enough not only to supply his own needs, but to sell to the dealers, and looked after every detail of the process as if wine-making had all along been the only occupation of his life. He took me with him on some interesting excursions in the neighbourhood, and warm though the weather was, he walked at a pace to which even young geologists are not accustomed in this country. It was delightful, too, to listen to his reminiscences of old times. He had known most of the geologists of note of the century, and had corresponded with all of them. He had amusing little personal recollections to give, mostly in English, which he would now and then, when the words failed him, exchange for German. He remembered down to the minutest details his life at Edinburgh and his rambles in Scotland. Now and then in a pause of our talk, as his memory drifted back again into the old student days, his face would lighten up with a sudden gleam of satisfaction as he would question me as to some quarry or brook-section he had visited more than half a century before, and which stood out as distinctly as if it were again in front of him. At his town house in Vienna, whither he used to return for the winter, he showed me his tabulated geological indices, in which he said that every geological work or memoir published in his time in every language was catalogued. It is much to be desired that these indices, which were carefully written out by himself, should be promptly published. They are particularly full, I believe, in the department of physical geology. Up to the last he retained his interest in the progress of the science, and communicated thoughtful papers on the work of others when no longer able to make original researches himself. The many long letters he wrote to me were always full of gossip as to the doings of his friends in Vienna, and shrewd remarks on passing events, scientific or otherwise. They were always in English, as I have said, but often with such strange idioms and spelling as occasionally made their meaning not very clear. I am tempted to give a quotation from one which I received from him in November, 1870, during the time of the Franco-German war:—"I was retain to late in the country this year by bad weather. My vintage did protract itself so late in October that we are hardly established comfortably now in town. Besides, the dreadful war preoccupations did take me all time from thinking at scientific matter, and now perhaps that distress will approach till nearer our abode. When you will know that I have very good and near parents in both armies and you perceive the possibility of parents killing themselves without recognising themselves, nor having the opportunity to do so, you will understand that I have often headach when I ride the newspapers or hear from the quite useless slaughters which have been prevented only by those men at the head of the human Society. I have parents in Paris, other exiled in Spain in England in Switzerland. The country houses of some by Paris are German hospitals or barracks. . . . As descending from Frenchmen I fill myself quite happy to be a German and to have remain such my whole life on."

With the regret that accompanies the severance of a tie that links us with so many interesting associations of the past there mingles in no common measure the feeling of personal bereavement. Retired for so many years in his Austrian retreat, Boué kept up the freshness of his youthful sympathy with progress and the kindliness of his hearty exuberant nature. May the dust lie light on his honoured head! To have even seen his round, good-natured face and sparkling eye was something to remember with satisfaction; but to have been privileged with his friendship was an honour the recollection of which will be more than ever precious to those from whom it has now been for ever withdrawn.

ARCH. GEIKIE

NOTES

THE International Exhibition of Smoke-abating Appliances at South Kensington was opened yesterday with great *éclat*. The opening meeting was held in the Albert Hall, the Lord Mayor in the chair, supported by the Marquess and Marchioness of Lorne, Doctors Siemens and Frankland, Captain Galton,

Sir H. Thompson, Lord Aberdare, and many men of science and others interested in the movement. The following awards will be made :—A prize of 100 guineas, given by Dr. Siemens; two prizes, together of about 100 guineas, given by ladies interested in the National Health and Kyrle Societies, for the best domestic fire-grate; the Society of Arts medals; a prize of 50*l.*, given by the Manchester Association for the Prevention of Noxious Vapours, and certificates to be awarded by the Council.

THE Annual Meeting of the Royal Society was held yesterday. The usual business was transacted. Part of the President's interesting address will be found in another column.

MR. H. N. MOSELEY, F.R.S., has been elected to the Linacre Chair of Physiology in the University of Oxford, vacant by the death of Prof. Rolleston. We heartily congratulate Prof. Moseley and the University of Oxford, whose appointment must be regarded with genuine satisfaction.

BARON NORDENSKJÖLD was in town for a few days last week, leaving again on Sunday, much to the disappointment of many who wished to make up for the poor reception he met with when he called here on his way home round Europe and Asia. It will be remembered that he reached London on a Good Friday, when no one expected him, and when we were in the throes of an exciting parliamentary election. His present visit was therefore looked forward to as affording an opportunity of showing worthily England's appreciation of his great work. Unfortunately, however, he was compelled to leave before anything could be done. Baron Nordenskjöld's narrative of his great voyage will be published in a very few days, and will, we believe, besides describing the incidents and discoveries of his own voyage, contain a narrative of research on the northern shores of Europe and Asia from the earliest times down to the present day. Its scientific value is likely to be very great.

IN consequence of an appeal from Mr. Leigh Smith's relations and friends, the Council of the Geographical Society on Monday last resolved to ask the First Lord of the Admiralty to receive a deputation from their body, accompanied by experienced Arctic navigators, who will urge upon him the necessity for taking immediate steps for the relief of the *Eira*. It is considered by Mr. Smith's friends that a well-equipped and commanded steamer alone can meet the requirements of the case, as it is not impossible that the *Eira* may have met with some serious disaster, and that it would certainly be necessary to visit without delay Eira Harbour and other points on the south coast of Franz-Josef Land. Perhaps a more modest request that two or three gunboats should at once be ordered to cruise up and down the ice-limit during the winter, and keep a bright look in all directions, might receive more attention, and would in the end probably prove as effective, and certainly less dangerous than the other plan. The *Eira* left Peterhead in the middle of June, and appears to have been only once spoken, viz. by the Norwegian vessel *Proven*. She first met the *Eira* on June 30, steering for the Matyushin Shar, and eight days later met her again steering a northerly course. It may fairly be assumed, therefore, that in the mean time Mr. Leigh Smith had made an ineffectual attempt to pass through the strait.

IN his report for the present year General W. B. Hazen, Chief Signal Officer of the United States, makes some useful remarks on International Polar research. From the progress made by the Signal Corps in the study of meteorology in late years, it has become clear that, owing to the very mobile nature of the atmosphere, the changes taking place in one portion of the globe—especially the Arctic zone—quickly affect very distant regions. The study of the weather cannot be properly carried on without a daily map of the whole of the northern hemisphere, and the great blank space of the Arctic region has long been a source of regret. General Hazen was, therefore, glad to co-operate in the work of the International Committee on Polar Research in their project for forming Arctic and Antarctic Stations. Their general object will be to accomplish by observations made in concert at numerous points such additions to our knowledge as cannot be acquired by isolated or desultory travelling parties. No special attempt will, he says, be made at geographical exploration, nor will there be any endeavour to reach the North Pole. The U.S. Signal Service undertook to organise two of these expeditions this year, one of which, as we know, was safely established under Lieut. Greely, in August last, at Discovery Harbour, Lady Franklin Bay, and we are glad to be able to announce that the other, under Lieut. Ray, was left in safety at Point Barrow on September 17 by the *Golden Fleece*, in which vessel it had been conveyed from San Francisco. The position of the former station, we may add, is in N. lat. 81° 40′, W. long. 64° 30′.

ON Monday last an unusually interesting paper was read before the Geographical Society by Mr. E. C. Hore of Ujiji, on his experiences in East Central Africa, and more particularly on Lake Tanganyika. His knowledge of Lake Tanganyika is unrivalled, as he has examined it carefully along its whole coast-line of some 900 miles, and he has crossed it in various parts. His description of the River Lofu, at the southern end, was very effective, and the same remark applies to the scenery of various parts of the lake-shore. Mr. Hore says that there are ten tribes living along its coast region, and he referred to their industries, including peculiar modes of fishing, and the species of co-operation among them which raised them far above the level of the natives on the sea-coast. He mentioned a number of the products of the country, among which are various kinds of timber used for making canoes, spear-heads, &c. Two species of crocodile are found in the lake, and Mr. Hore created some amusement by saying that Stanley's water-hyænas, on investigation, turned out to be otters. Owing to the singular formation of the lake, its depth is a matter of some interest; but all Mr. Hore can say is that he could obtain no bottom with about 170 fathoms of line. Among the other matters dealt with were visits to the Lukuga outlet of the lake, the current of which has lately got much slacker, and the Malagarasi, one of the largest rivers emptying into the lake. At Mr. Hore's first visit the latter was 500 feet broad, with a swift current and rapids five and a half miles from its mouth. On subsequent visits the channel was found comparatively empty, a result largely brought about by the lowering of the lake level.

MR. E. C. HORE has presented to the Geographical Society the map of Lake Tanganyika which he constructed from careful surveys and observations made during his various explorations, the results of which he described in his paper above referred to.

M. PLATEAU describes as "*un petit amusement*" the following experiment :—A flower like a lily, with six petals each about an inch long, was constructed in outline in thin iron wire; the wire being first slightly peroxidised by dipping for an instant into nitric acid. This wire frame was then dipped into a glyceric-soap-solution, which, when it was withdrawn, left soap-films over the petals. The stalk was then set upright in a support, and it was covered by a bell-glass to protect it from air-currents. In a few moments the most beautiful colours made their appearance. If the solution is in good condition the films will last for hours, giving a perpetual play of colour over the flower.

THE stories which we have from time to time heard respecting an alleged discovery of relics and journals of the long-lost explorer, Dr. Ludwig Leichhardt, and upon which discredit has lately been thrown, would appear to have some foundation after all, for by the last Australian mail news has been received that

the New South Wales Government have agreed to the somewhat exorbitant demands of the bushman, Mr. J. R. Skuthorpe, and will give him 6000*l*. for the relics, &c., provided their genuineness be established by certain tests. Mr. Skuthorpe has now no excuse for keeping his alleged "find" buried in the far interior, and it cannot be long before the matter will be settled one way or the other. Mr. Skuthorpe is stated to have given an outline of the contents of the journals, among which are accounts by Classen of Dr. Leichhardt's death and his own life among the natives.

PROF. HAECKEL is at present in Ceylon, where he is to stay for three months for a scientific exploration of the island.

THE German Government is considering the participation of German men of science in the plan of International Polar Research. The Reichstag has been asked to grant the necessary funds, which are fixed at 300,000 marks (15,000*l*.). Besides this sum 180,000 marks (9000*l*.) are asked for the Transit of Venus Expedition in 1882, and 75,000 marks (3750*l*.) for expeditions to Central Africa.

THE forthcoming lecture arrangements at the Royal Institution will include the usual Christmas course of six lectures, to be given this year by Prof. R. S. Ball, the Astronomer-Royal of Ireland, on the Sun, Moon, and Planets (with illustrations by the electric light, &c.). Eleven lectures by the new Fullerian Professor of Physiology; four lectures by Prof. H. N. Moseley on Corals; four lectures by Dr. P. L. Sclater on the Geographical Distribution of Animals; three lectures by Prof. Tyndall; four lectures by Prof. Pauer on Louis van Beethoven (with illustrations on the pianoforte); four lectures by Mr. W. Watkin Lloyd on the Iliad and Odyssey. The Friday evening meetings will begin on January 20 at 8 p.m. Dr. W. Huggins will give a discourse on Comets. Succeeding discourses will probably be given by Mr. R. S. Poole, Professors Odling, Frankland, J. G. M'Kendrick, and W. E. Ayrton, Capt. Abney, Mr. A. Tylor, Mr. J. W. Swan, Mr. W. Spottiswoode, and other gentlemen. Mr. H. H. Statham's four lectures on Ornament, delivered at the Royal Institution, are to appear in the Portfolio for January and following months.

PREPARATIONS are being made in Edinburgh for the celebration of the centenary of Sir David Brewster's birth next month.

MR. EDISON has entered the field of competitors in the construction of storage batteries for electric currents. His particular method of storing currents has however not yet been made public.

THE *Daily News* Naples correspondent writes that a small party of travellers is proceeding to India, one of whom is Paolo Mantegazza, the organiser of the expedition, the object of which is, on his part, to make anthropological studies of the Indian races, and to collect skulls and bones for the Museum at Florence. One of his companions, Signor Fabricotti, a naturalist, will collect animals and plants, and the other, Signor Michela, an artist, will reproduce or copy the antique Indian ornamentation of the monuments, china and bronzes, that adorn Indian temples and houses. Signor Mantegazza is particularly interested in the races of the Himalaya, and, after a general survey of India, it is to this region that the attention of himself and of his companions will be especially devoted.

HERR J. N. AROSENIUS gives in the last number of the *Zeitschrift für die wissenschaftliche Geographie* (vol. ii. fascicule 5), an account of the ethnographical frontier between Finns and Swedes in Northern Sweden. This frontier does not coincide either with the old one, which ran along the range of hills between the Torneo and Kemi rivers, or with the present one which runs along the Torneo. It begins on the shore of the Gulf of Bothnia, between the post stations Sangits and Säivits, and runs straight north to the Kengis iron-works. But some three or four hundred miles south-west of this frontier there are in Sweden numerous small patches inhabited by Finns, which patches make a broken chain going from the Wermland to the Medelpad province. The flat land and the valleys altogether are inhabited by Swedes, but nearly everywhere in the most remote parts of the forest are to be found one or several Finnish houses, built in the old Finnish fashion. Isolated in the wilds, Finnish people in Sweden gradually forget their former language, and mostly speak Swedish, especially after having reached a certain age. In the province of Dalarne the Finnish language is quite forgotten by the Finns, and their origin can be discovered only by their customs, dwellings, and by very few remains of their former language; thus M. Arosenius has seen a woman who knew only a single Finnish sentence, one of the most frequently used, however, "Light me the pipe." As to the remains of Finnish population in the province of Smaland, the question still remains open; but it is proved that there are remains of two different peoples, one of which must have been of Lapp origin, whilst the other, which knew the use of bronze implements and agriculture, must have been, M. Arosenius thinks, Finnish.

DON JUSTO ZARAGOZA contributes to the *Boletin* of the Geographical Society of Madrid a series of interesting papers on ancient canal schemes between the Atlantic and the Pacific in Central America. There were three places which the Spanish of the sixteenth century thought of for these schemes: the isthmus of Tehuantepec in New Spain, now Mexico; the river of San Juan, of the Lake of Nicaragua, in the republic of the same name; and the Chagre River, and other parts of the Isthmus of Panama. The investigation of Tehuantepec was abandoned at that time, to be renewed in our century; those of Nicaragua were actively pursued in the seventeenth century, and were nearly being executed about the middle of the eighteenth century, during the reign of Charles III., and the scheme of a canal through the Isthmus of Panama, also abandoned, has now been renewed by M. Lesseps. In the paper published in the October number of the *Boletin* D. Zaragoza gives interesting information on the little-known scheme of a canal *viâ* the Lake of Nicaragua, which scheme appeared in the year 1548, with a map of the land prepared by Arias Gonzalo. In 1606 Captain Ochoa de Leguizamo explored, on the same account, the Puertos de Caballos and Fonseca Bay; and during the years 1780 to 1783 a map of the projected canal, still existing, was prepared, and a survey was made between the Pacific and the Lake of Nicaragua, which last proved to be 133 Castilian feet above the sea-level, the height of the water-shed being 604 feet. This scheme met with great opposition, the chief reason for which was found in the statement of Juan Bautista Antonelli, an engineer sent by Philip II., who declared the scheme quite impracticable; and D. Zaragoza publishes an interesting memoir, by J. Antonio de Escartin, to prove the possibility of the canal. The paper will be continued.

PROF. A. H. CHURCH gives a course of lectures on Chemistry at the Royal Academy of Arts on December 2, 7, 9, 12, 14, and 16; of course the lectures will have special reference to the bearing of Chemistry on Art.

ADMIRAL MOUCHEZ is continuing with vigour the completion of his astronomical museum. Eight oil paintings have been placed in the foreign astronomers' room, representing respectively Copernicus, Tycho Brahé, Galileo, Kepler, Huyghens, Newton, Bradley, and J. Herschel. A large number of engravings and photographs, representing either celebrated astronomers, large instruments, or foreign observatories, have been collected in the same room.

A VERY hopeful Report has been published by the Winchester College Natural History Society. This is its Fifth Report, though the Society has been in existence ten years. It has not been thought necessary to publish any account of the doings of the Society for five years, though we are assured that it has been none the less doing good work. This is what is wanted, and the present report bears evidence that the Winchester Society is in a healthy and fairly vigorous condition. The sectional reports are good, and the Society has formed some very fair collections.

THE Berlin Philosophical Society, founded in 1843 by the disciples of Hegel, but now numbering amongst its members men of the most various philosophical creeds, has applied the surplus of funds recently collected for a monument in memory of Hegel to the foundation of a Hegel Institution, the object of which is the furtherance of philosophical research. The Society has just issued the following prize theme: "A critical and historical account of the dialectical method of Hegel." The treatises may be written either in German, French or English, and must be sent in before December 31, 1883. The prize is 450 marks (22*l.*).

A NEW natural history serial will soon be published by Enke of Stuttgart. Its editor is Dr. Georg Krebs of Frankfort on the Maine, and its title, *Humboldt, Monatsschrift für die gesammten Naturwissenschaften.*

THE "Encyklopædie der Naturwissenschaften," published by Trewendt of Breslau, is now well advanced. Part 25 contains the seventh instalment of the Dictionary of Zoology, Anthropology, and Ethnology, and only brings it down to *Distoma.* Parts 26 and 27 contain the eleventh and twelfth (the concluding) instalment of the Handbook of Mathematics.

DR. NAGORSKY, having measured the capacities of lungs of 630 boys and 314 girls in the schools of the district of St. Petersburg, now publishes the results of his investigation in a Russian medical paper, the *Surgeon.* He has found that the capacity of lungs, in relation to the weight of the body, is 65 cubic centimetres for each kilogramme of weight in boys, and 57 cubic centimetres for girls. The law of Quetelet being that with children below fifteen years of age, the weight of the body is proportionate to the square of the height, Dr. Nagorsky has found that it is proportional to 2·15 of the same; whilst the capacity of lungs is proportional to 2·4th of the height for boys, and to the square of the height for girls. Dr. Nagorsky's researches will soon be published as a separate work. As to the relation between the weight of man and the capacity of lungs, it is tolerably permanent, and its variations are mostly due to differences in the amount of fat in the bodies of different men.

IN our article on the Geological Congress (NATURE, November 10) in the table of terms, in the first column of p. 35, the word *Cycle* should be *Ère* (*era*).

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. R. M. Edger; a Blackbird (*Turdus merula*), two Song Thrushes (*Turdus musicus*), a Starling (*Sturnus vulgaris*), two Skylarks (*Alauda arvensis*), a Greenfinch (*Ligurnis chloris*), two Chaffinches (*Fringilla cælebs*), two Common Quails (*Coturnix communis*), British, presented by Mr. Edward Lawrence; a Black-winged Peafowl (*Pavo nigripennis*) from Cochin China, presented by Mr. J. Marshall; a Common Kestrel (*Tinnunculus alaudarius*), British, presented by Mr. A. Lidbury; a Grecian Ibex (*Capra ægagrus*) from South-East Europe, four Orange-cheeked Waxbills (*Estrelda melpoda*), two Common Waxbills (*Estrelda cinerea*) from West Africa, two Maja Finches (*Munia maja*) from Malacca, a Black-headed Finch (*Munia malacca*), an Indian Silver-bill (*Munia malabarica*) from India, a Song Thrush (*Turdus musicus*), British), a Blue-crowned Parrakeet (*Tanygnathus luzonensis*) from the Philippines, a White-eared Conure (*Conurus leucotis*) from Brazil, deposited; a Bar-tailed Godwit (*Limosa lapponica*), two Razorbills (*Alca torda*), two Common Lapwings (*Vanellus cristatus*), two Golden Plovers (*Charadrius pluvialis*), two Knots (*Tringa canutus*), a Red-throated Diver (*Colymbus septentrionalis*), British, purchased; a Spotted Ichneumon (*Herpestes auropunctatus*) from Nepal, a Geoffroy's Dove (*Peristera geoffroii*), two Brazilian Teal (*Querquedula brasiliensis*) from South America, two Mandarin Ducks (*Aix galericulata*) from China, received in exchange.

OUR ASTRONOMICAL COLUMN

THE SATURNIAN SYSTEM.—In a memoir published in t. xxvii. 2^me partie, of *Mémoires de la Société de Physique et d'Histoire Naturelle de Genève*, entitled "Recherches sur Saturne, ses Anneaux et ses Satellites," M. Wilhelm Meyer, assistant-astronomer at the Observatory of Geneva, presents results of his observations made with the 10-inch refractor, the gift of Prof Plantamour to the establishment, during the opposition of 1880. They consist of measures of the rings and equatorial and polar diameters and observations of the satellites Enceladus, Tethys, Dione, Rhea, and Titan, with elements deduced from them. M. Meyer was not certain that he had observed Mimas in 1880, but in a note he mentions that on the night of September 4, 1881, which was "une des plus belles, quant à la diaphanité de l'atmosphère," he obtained an undoubted observation of it; at 13h. 13m. 27s. Greenwich mean time it was distant 31″·1 from the centre of Saturn, exactly in the plane of the ring on the preceding side, or, as he expresses it, $x = -31''{\cdot}1$, $y = 0$.

For the outer diameter of ring A he finds 40″·47 for the mean distance of Saturn, which, like other measures with the filar-micrometer (employed for all the measures at Geneva) is in excess of the results given by the double-image micrometer; Kaiser found the outer diameter with the latter 39″·47. Considering the difficulties attending measures of this class with the filar-micrometer, preference, no doubt, is to be given to the double-image principle, though without much practice there may be a tendency to *clip* the measures made with the instrument. If it were preferred to take something like a general mean of the reliable measures to this time, the outer diameter of the ring would be found to differ little from 39″·75.

M. Meyer has referred all his times to the meridian of Greenwich, because, as he says, it is that adopted by Mr. Marth in the calculation of his elaborate ephemerides of the satellites, to which he acknowledges his obligations.

We subjoin the elements of the four satellites interior to Titan which were measured at Geneva:—

	ENCELADUS	TETHYS	DIONE	RHEA
Epoch	Oct 8·0 ...	Oct. 27·0 ...	Oct. 27·0 ...	Oct. 27·0
	° ′	° ′	° ′	° ′
Mean long.	5 18·3 ...	300 2·2 ...	155 5·2 ...	309 42·9
Peri-Saturnium ...	181 45·3 ...	204 6·8 ...	180 16·8 ...	239 26·0
Node	127 5·9 ...	113 57·6 ...	124 17·0 ...	127 4·5
Inclination	4 38·0 ...	7 0·7 ...	6 41·5 ...	6 36·2
Eccentricity	0·066235 ...	0·006847 ...	0·016888 ...	0·014657
	″	″	″	″
Semi-axis major ...	34·29 ...	42·48 ...	54·58 ...	75·97
	d. h. m. s.	d. h. m. s.	d. h. m. s.	d. h. m. s.
Tropical revolution	1 8 52 40·5 ...	1 21 18 8·4 ...	2 17 40 54·1 ...	4 12 25 25·4

The node and inclination are referred to the plane of the terrestrial equator.

The separate values of the mass of Saturn which M. Meyer deduces from his observations are discordant.

THE LUNAR ECLIPSE ON DECEMBER 5.—The eclipse of the moon next Monday evening, though very nearly total, will not be actually so, the magnitude being 0·973. The first contact with the shadow occurs at 3h. 28m., but the moon does not rise at Greenwich till 3h. 50m. The middle of the eclipse occurs at 5h. 8m., and the last contact with shadow at 6h. 49m. The shadow enters upon the moon's surface at about 60° from the N. point of the limb towards the east. The fifth magnitude star ι Tauri is occulted at Greenwich at 6h. 23m., before the shadow is off the disk.

On October 13, 1856, there was a lunar eclipse of similar character, magnitude 0·994.

VARIABLE STARS.—R Leporis. According to Dr. Julius Schmidt's observations during the interval 1865–1875, the mean

period of this variable appears to be about $436\frac{1}{2}$ days, and a maximum may be expected about January 19, 1882; its magnitude at maximum has been estimated 6·5 by Schmidt and 6 by Gould; at minimum it is about 8·5. Observations of the degree of intensity of colour in this "crimson star" are desirable, as there are indications that it has varied with variation in brightness. At times it has been recorded that the red colour was not particularly striking, whereas at the first observation of this star in October 1845 it arrested attention whilst comet-sweeping. (2) R. Draconis. Dr. Schmidt noted a maximum on April 22 in the present year, or 251 days after the preceding one, so that another maximum may be looked for about December 29. The star is Lalande 30387, and its variability was detected at Christiania; the position for 1882·0 is in R.A. 16h. 32m. 20s. Decl. + 67° 0'·1; it is followed by a star 8·9m. (L 30413) by 53s., 1'·5 to the south of it. Prof. Pickering's suspected variable of 1881, September 13, is about $5\frac{1}{2}$° to the north; R.A. 16h. 31m. 32s., Decl. + 72° 32'; it is "red, spectrum-banded."

(3) μ Cephei (Bayer) is probably now on the increase, but we do not find very recent observations; the position of this "garnet-sidus" for 1882·0 is in R.A. 21h. 39m. 53·7s., Decl. + 58° 14' 21"; Argelander's mean period is 432 days, Prof. Schönfeld calls it "irregular."

THE ROYAL SOCIETY—ADDRESS OF THE PRESIDENT

ON the occasions of our anniversary our first glance is usually retrospective, in memory of those once among our numbers, but now surviving only in their works. On our home list we have this year lost more than a score of Fellows. On the foreign list we have lost but one; that loss will however be severely, if not so widely, felt.

In Michael Chasles mathematicians recognise a geometer of unusual powers, who, having devoted a long life to his favourite study, has left an extensive and characteristic train of researches behind him. But a larger circle of friends recognised in him a great and good man, beloved by all who knew him, and respected beyond the range of his personal acquaintance. As a pure geometer he belonged to a class of mathematicians for which the Academy of Sciences of Paris has long been justly celebrated; but whose numbers appear liable to a perceptible fluctuation, perhaps partly owing to the brilliant opportunities and the varied fascinations which modern algebra offers to the student. Eminent in a nation which has always been intolerant of obscurity in science, he showed in a remarkable degree how much might be elicited through precision of thought and by clearness of exposition from a few well-selected and fertile ideas. Such, for instance, proved to be the consideration of Anharmonic Ratios, the principle of Correspondence, and the method of Characteristics. Whether in the latter he had struck a vein so completely out of the range of the analyst, as he himself supposed, may perhaps be still claimed as an open question; but certain it is that he showed the fertility of the method by continuing to deduce from it an apparently inexhaustible flow of theorems, even after the more serious part of his mathematical work had been done. And there is little doubt that long after the time when many subsequent works have fulfilled their purpose, and have fallen into a natural oblivion, his "Aperçu Historique," his "Géométrie Supérieure," and the fragment of his "Traité des Sections Coniques," will be regarded as classics in the library of the mathematician.

Turning to the home list, the remark made in my last address, viz. that our losses had been mainly among our older Fellows, might be repeated with even more emphasis on the present occasion. Of the twenty-two who have died during the intervening period nine had reached the age of three score and ten, eight that of four score, and one, Dr. Billing, had attained his ninety-first year.

In Lord Beaconsfield and Sir James Colvile we have lost two distinguished members, elected under the statute which gave a new definition of the privileged class a few years ago. Lord Hatherley will be recollected as having served on our Council within recent years, and as having often given us very useful advice on subjects requiring the sound judgment of an experienced mind. Although Lord Hatherley would doubtless have been elected, as a member of the Privy Council, under the statute above mentioned, it is perhaps worth remark that he was elected under statute previously existing, and that his fellowship dated from the year 1833.

The late Dean of Westminster furnishes another instance of the wise exercise of a power which the Royal Society has always reserved to itself, notwithstanding the changes made in 1847, of electing from time to time men of eminent distinction in other avocations of life than those of strict science. Of Dr. Stanley's attainments and merits in those other directions it is not my province to speak; and, indeed, it is the less necessary that I should do so, for they were so many and so varied that in one way or other they were known to all. But he was conspicuous, both among the members of his own profession and among many others who have neither predilection nor training for actual science, for his genuine and honest sympathy with its principles and its objects, and with the labours of those who cultivate it.

In Dr. Lloyd, whose age was coeval with the century, and who was a fellow-worker with Herschel, Whewell, Peacock, and Sir W. R. Hamilton, we seem to have lost one of the links which connected us with a past generation. While himself no mean mathematician, he was distinguished especially in the sciences of optics and of magnetism. In the subject of optics he had the rare opportunity of supplying the experimental verification of Sir W. R. Hamilton's brilliant geometrical conclusions on the configuration of the wave-surface; and it was largely due to his patience, his delicacy of touch, and his almost instinctive sagacity, that the phenomena of conical refraction were first made visible to the human eye. In magnetism he assisted in the formation of the great survey of the globe, initiated by Sir E. Sabine, and as director of a magnetic observatory in Dublin he made valuable contributions to the subject. His scientific remains, brought together in one volume, have been a welcome addition to the library both of the mathematician and of the experimentalist. His interest in science and in its promoters was active throughout his long life; and those on whom the honorary degree of LL.D. was conferred at the late meeting of the British Association in Dublin, will always cherish as a pleasant reminiscence the fact of having received it at his hands.

Dr. Bigsby was one of the earlier cultivators of Geology. Some of his first studies were made at a time when the subject was hardly a science; but in attaining the advanced age of eighty-nine he lived to see it what it has since become. He founded a medal at the Geological Society, of which he was for many years a member.

We are again reminded of the progress which has been made in science, and in the cultivation of it during the present generation, by the fact that until the last day of last year we could reckon among our Fellows Dr. John Stenhouse, one of the surviving founders of the Chemical Society.

On the subject of our property there is little change to report. Further investments have been made in due course on account of the Fees Reduction Fund. The sale of the Acton estate has not yet been completed, but a deposit is in hand, and a half year's interest on the balance has been received.

The Charitable Trusts Bill, which was introduced into Parliament last session, and which would have affected our interests had it not been for a clause introduced by our Fellow the Marquis of Salisbury, specially exempting the Royal Society from its operation, was withdrawn.

The collection of portraits in the possession of the Society has been enriched by the addition of a portrait of Sir Joseph Dalton Hooker, painted by John Collier, Esq., at the expense of a considerable number of our Fellows, who were desirous of expressing their sense of the important services rendered by Sir Joseph to the Society, and at the same time of securing a permanent memorial of their late president. It is to be hoped that advantage may be taken of any suitable occasions that may arise from time to time of adding to our gallery of historical records of the great men whom we have reckoned among our Fellows.

The Fellows will learn with satisfaction that the first part of the new edition of our library catalogue is published. This part, consisting of 232 pages, contains the *Transactions*, *Proceedings*, and *Journals* published by societies and institutions in nearly all parts of the world; and also the observations, reports, and accounts of surveys which are to be found in our library. As our Library Committee has always devoted great attention to securing by exchange or by purchase publications of this class, and as the main strength of our library consequently lies in our collection of them, the part in question will form the most important section of the entire catalogue.

[1] Address of William Spottiswoode, D.C.L., LL.D., the president, delivered at the anniversary meeting of the Royal Society on Wednesday, November 30, 1881.

Progress has also been made in the more voluminous portion of the catalogue, viz. that of the general collection of scientific books, of which thirteen sheets, extending to the end of the letter C, are printed off, or are in type; and subsequent titles are in type. It may fairly be hoped that before our next anniversary the whole will be published.

The last part of the *Philosophical Transactions* for 1880 was published in March of the present year, completing a volume of nearly 1100 pages, with upwards of fifty plates. Of the *Transactions* for 1881, Parts I. and II. have already appeared; from which an early publication of Part III. may be anticipated.

Of the *Proceedings*, vol. 31 was published in June, and vol. 32 at the end of October.

Although, as I remarked last year, we are more concerned with the quality than with the quantity of the communications made to the Society, it may still be interesting to carry on the table of the number of papers presented per annum to a tenth year. It stands as follows:—

1872	99 papers received.
1873	92 ,, ,,
1874	98 ,, ,,
1875	88 ,, ,,
1876	113 ,, ,,
1877	97 ,, ,,
1878	110 ,, ,,
1879	118 ,, ,,
1880	123 ,, ,,
1881	127 ,, ,,

These 127 papers include one from Mr. Brooks of Baltimore, two from Prof. Helmholtz, and one from Capt. Mannheim, of the École Polytechnique, Paris. On reference to the papers themselves it will be noticed that several prominent men are carrying on with vigour the series of researches on which they have been, in some cases for years, engaged. Among them there may be mentioned, in physics, those of Professors Liveing and Dewar, and of Mr. Lockyer, on the Spectra of Terrestrial Substances and of the Sun; those of Prof. Hughes on Minute Interactions of Electric Currents and Magnetism; those of Mr. Crookes on High Vacua; and those of Mr. H. Tomlinson on the effect of Stress and Strain on the action of Physical Forces. Mr. G. H. Darwin continues his already classical memoirs on the mechanical history of the solar system; and Capt. Abney has opened out to view, by photographic means of his own invention, a part of the spectrum of the sun and of other bodies, beyond the red, hitherto invisible; and last, but not least, Prof. Tyndall in his Bakerian Lecture has given an account of his researches on the action of Free Molecules on Radiant Heat, and its Conversion thereby into Sound. In Biology I may mention the investigations of Mr. Romanes on nerve systems; those of Prof. Ferrier on the connection between special portions of the brain and special motor organs of the animal system; those of Mr. Parker on the Skull of the Batrachia, and of Prof. W. C. Williamson on the fossil plants of the Coal-measures. Among the newer subjects, the experiments of Dr. Young and Prof. George Forbes on the velocity of light of different colours have naturally arrested considerable attention for several reasons, and especially because the conclusions thence deduced, if ultimately established, would fundamentally modify our views of the constitution of the luminiferous ether.

For several years past I have been able with much satisfaction to report that there had been no change in the staff of officers of the Society. I much wish that I could have done so again. But the longer a capable man lives and is available, the more will work accumulate on his hands; and the time at last comes when something must be given up, lest, in the multiplication of avocations, powers which might otherwise have been devoted to some great and good purpose, and on operations not within the grasp of every one, should become dissipated among a variety of objects. A feeling that life must not be spent merely in running hither and thither, and a desire that it should be something better than a mere feat of mental agility exhibited in passing rapidly from one occupation to another, doubtless operated in leading Sir Joseph Hooker to resign the presidentship; and a similar feeling has recently led to the resignation of the secretaryship by Prof. Huxley. That this loss is great will be felt by every Fellow of the Society; it will be more keenly felt by his brother secretaries and the treasurer, but most of all by your president. Connected as I have been with him through a series of years by ties of office in the Society, by bonds of friendship and trust as thorough as can exist between man and man, I cannot but miss for a long time to come his ever willing support, his sound counsel and advice, and the cheery manfulness with which he would always address himself to any business, however difficult, uninviting, or heavy.

The post is one which it is not easy to fill. Many qualifications go to make up a good secretary; and although none of us so "despaired of the republic" as to doubt that a good successor would be found, we still felt some anxiety until we were in a position confidently to recommend a name for your consideration. Prof. Michael Foster's great scientific attainments, his administrative powers as shown in founding the great School of Biology at Cambridge, the confidence with which he inspires all around him, alike point him out as a man eminently fitted for the post. It would indeed have been agreeable to your president to have had one of the principal secretaries resident in London; but the means of communication are now so different from what they formerly were that questions of distance almost disappear; and it is certainly not without its advantages that the two principal secretaries, if not resident in London, should reside in the same city.

In the course of the spring of the present year Sir Joseph Copley, the present representative of the Founder of the Copley Memorial, explained in a visit to the president his wish to "provide in perpetuity an annual bonus of 50*l*. a year, to be given to the recipient of the Copley Medal." As the donor's views on the terms of the gift were completely made up, and were not offered for discussion by the Society, or otherwise open to modification, the Council decided to accept the offer in the spirit in which it was made, and on the terms prescribed. In accordance with this, Sir Joseph transferred a sum in Consols sufficient to provide for the bonus proposed. This acceptance will not in any way affect the adjudication of the Medal, nor, it is to be hoped, the high estimation in which that award has always been held.

The period of five years during which the experiment of the Government Fund of 4000*l*. per annum was to be tried has now expired. In a former address I have expressed opinions gathered from many of the Fellows of the Society, and have indicated my own. The President and Council have now, at the request of the Department of Science and Art, through which the vote is made, drawn up a report on the question, based upon the experience gained up to the present time, and have made suggestions with a view to a modified arrangement for the future. The Society will be duly informed of the result of those communications. In the mean time it may not be out of place to remind the Fellows that a statement of all grants made within the year is published in the report of our anniversary proceedings.

The report of the *Challenger* Expedition, of which mention was made last year, is in the course of publication; and three volumes have now appeared. Copies of these have been presented by the Treasury to our library. Vols. ii. and iii. refer to the curious forms of life found in what Sir Wyville Thomson has called the "Abysmal Region," and are copiously illustrated with lithographs. The interest which attaches to this publication is evinced by the fact that the first edition of the second volume is already exhausted. A second edition of it is in the course of printing. The Fellows will doubtless have observed that the printing of the text and the execution of the plates are maintained at the same high standard as that exhibited at the outset.

Among other scientific publications of the year, I may mention the third volume of Roscoe and Schorlemmer's work on Chemistry; Mr. Balfour's on Embryology; and Mr. Darwin's on Vegetable Mould.

In December last the Council authorised the loan of the *Philosophical Transactions* from one of our complete sets, five volumes at a time, to the Delegates of the Oxford University Press, for the preparation of a Philological English Dictionary, under the editorship of Dr. Murray. It is hoped that this loan will contribute to the completeness of the work in respect of scientific terms. Forty-one volumes have been already utilised in this way.

Towards the close of last session a communication was received from the India Office inclosing a copy of a report and memorandum, on Pendulum Observations, by Major Herschel, and asking the advice of the President and Council thereon. Subsequently there followed another communication from the same office, inclosing a copy of a letter from the same officer, with an extract from a letter to him from Mr. Peirce of the United States Coast Survey. These documents were referred

to a Committee consisting of Sir George Airy, Prof. J. C. Adams, and Prof. Stokes.

The Report of that Committee was forwarded to the India Office; the following extracts from it contain those parts which refer to the main scientific questions raised:—

"The object in referring these documents to the Royal Society was to assist the India Department in coming to a conclusion as to what, if anything, might yet be required in order to render the pendulum operations which have been carried out in connection with the great trigonometrical survey of India reasonably complete as an important contribution towards the determination of gravity all over the earth.

"At present the stations which have been directly connected with the Indian stations are confined to Aden, Ismaïlia in Egypt, and Kew; and no one of these has been differentially connected with any of the chains of stations that have hitherto been used in the determination in this way of the figure of the earth, though Kew is now a station at which an absolute determination has been made. We think it would be a reasonable expectation on the part of the scientific public that the Indian group of stations, which have already been connected with Kew, should be differentially connected with at least one chain of stations which are so connected with one another, and which have been employed in the determination of the figure of the earth.

"We approve accordingly of the suggestion that gravity at Kew should be compared, by means of invariable pendulums, with gravity at another station belonging to another group. Greenwich has been named as such a station.

"In connection with this subject, we would refer to the suggestion, which has been brought before us, made by Mr. Peirce, of the United States Coast Survey, that Major Herschel should swing the same two pendulums that were used in India, first at Kew and then at Washington.

"As Washington is, or shortly will be, connected differentially with a large chain of stations widely distributed in America and elsewhere, we think that the value of the Indian series would be decidedly increased by being connected with one of the American stations, such as Washington. We think, however, that its connection through Kew with one of the older series should not on that account be omitted.

"The observations required for the purpose of these connections are such as certainly can be made, and have been made, by existing methods; and the labour of making them, which will be approximately in proportion to the number of stations at which the pendulums will have to be swung, is only a fraction of that already incurred on the Indian stations, and the three which have been included in the same group with them."

In October last a letter was received from the Treasury asking the opinion of the President and Council respecting arrangements for observing the transit of Venus in 1882. Under the advice of a Committee appointed for the purpose, it was recommended that a special Committee of the Royal Society should be appointed to decide upon the observations considered essential, and to advise Her Majesty's Government as to the best method of carrying them out. In conformity with this advice, and at the request of the Treasury, a Committee was appointed to draw out a scheme of stations, and of the constitution, strength, and equipment of the observing parties, and to frame an estimate of the total cost. The Committee reported recommending the adoption of certain stations in South Africa, the West Indies, Australia, and New Zealand, and the Falkland Islands; and they at the same time added other particulars, and furnished an estimate of the whole, adopting in the main the recommendations of that Committee; the Treasury then requested the President and Council to nominate an Executive Committee, by which (accounting to the Treasury) any vote of Parliament for the purpose of these observations might be administered; and under whose advice the observers and assistants might be selected and appointed. In compliance with this request the following Fellows were nominated as an Executive Committee, viz. the President, Prof. J. C. Adams, Sir G. Airy, Mr. Hind, Sir G. Richards, Prof. H. J. Smith, and Mr. Stone. That Committee is now continuing its labours, and has appointed its member, Mr. Stone, of the Radcliffe Observatory, Oxford, directing astronomer of the expeditions; and under him the selection of instruments, as well as the training of the observers, will be made.

With a view of making the observations ultimately as comparable as possible, the Committee, at an early stage, put itself, through the Foreign Office, into communication with the corresponding Commissions in foreign countries, on the subjects of the instructions to be given to the various observers; and a draft set of instructions, drawn up for this purpose, was circulated for comment and suggestion.

Moved perhaps in some degree by this action, the Governme n of France took advantage of the assemblage of scientific men collected in Paris for the Electrical Congress and Exhibition, to summon a Congress of Astronomers, having especially in view a consensus of arrangements for the observation of the Transit. This Congress met in Paris on October 5, under the auspices of the Minister of Public Instruction. M. Dumas was appointed President; MM. Foerster and Weisse, Vice-Presidents; MM. Tisserand and Hirsch, Secretaries. The various countries of Europe were represented; but it was a matter of much regret that no representative from the United States of America was present. Mr. Stone attended on behalf of the British Committee. I must here express my regret at having been unable to attend in person to support our directing astronomer, who made the journey at much inconvenience to himself; but I should at the same time add that my absence in no way diminished the effectiveness of Mr. Stone's counsels, which proved of great service in promoting a unanimity in the views finally adopted by the Congress.

Two Committees were appointed: (1) for the selection of stations; (2) for a discussion of methods of observation.

As the British stations had been already chosen, and did not admit of material alteration, the first of these Committees did not directly concern us. But, judging from the number of observations contemplated to be made in South America by foreign expeditions, it seems not impossible that the party which we had proposed for the Falkland Islands might be advantageously transferred to some other locality, so as to strengthen the parties requiring support, for example, in Australia.

As regards the discussion of methods, the draft instructions drawn up by the British Committee, and especially the definition of contact to be observed, strongly insisted upon by Mr. Stone, were in the main adopted. The following are the principal points agreed upon:—

With a view to uniformity of method of observation it is necessary that instruments of nearly the same aperture (six inches) should be used, also that the observations of contact should be made in a field of just sufficient brightness to allow of the clear separation of two threads at one second of arc apart when seen projected on the sun with a power of 150. The times corresponding to the internal contacts should be defined as follows:—

At Ingress.—"The time of the last appearance of any well-marked and persistent discontinuity in the illumination of the apparent limb of the sun near the point of contact."

At Egress.—"The time corresponding to the first appearance of any well-marked and persistent discontinuity in the illumination of the apparent limb of the sun near the point of contact."

It is a point of primary importance that all the observers shall, as far as possible, observe the same kind of contact; and it is therefore desirable that the times recorded for contacts should refer to some marked *discontinuity* in the illumination of the sun's limb about which there cannot be a doubt, and which may be supposed to be recognisable by all the observers. If a pure geometrical contact is alone seen, there can be no doubt about the time which should be given; but, if haze is noted, it should be haze nearly as dark as the outer edge of the planet; and if a ligament is seen, it should be nearly as dark as the outer edge of the planet.

A further proposal was made to establish a Central Bureau in Paris to receive and discuss the observations, and to enter upon other work more or less directly connected with the determination of solar parallax. But, as this question was not contemplated in the instructions given to our representative, and indeed exceeded the powers of the British Committee, no definitive resolution was passed on the subject.

On the subject of the longitude of a point in Australia, to which I made allusion in my address last year, as important for the observations of the transit of Venus, I have lately received a letter from Mr. Todd, of the Observatory, Adelaide, from which the following is an extract: "With regard to the determination of Australian longitudes: as it is understood that Lieut.-Commander Green, U.S.N., will call at Port Darwin to determine its longitude by signals from Singapore on the one side, and with the Adelaide Observatory on the other, I have taken no further steps for going to Port Darwin, as previously arranged. I shall take all the necessary observations here, and

exchange signals with Lieut.-Commander Green over my overland telegraph; and, in conjunction with Messrs. Ellery and Russell, make fresh determinations of the difference of longitude between Adelaide, Melbourne, and Sydney."

Since our last anniversary, Sir George Airy, the late Astronomer Royal, having completed his eightieth year, and nearly half a century of office, has retired. Of his services to science, and to this Society as President, and in other ways, the time to speak has happily not yet arrived. His great intellectual powers are in fact in no way impaired, and so far from having brought his period of activity to a close, he hopes to employ his well-earned leisure in completing a favourite work, the Numerical Lunar Theory.

His successor, Mr. Christie, from his long experience in the Royal Observatory, will combine a thorough training in the remarkable organisation and methodical administration for which his predecessor was so conspicuous, with the full vigour of life, and an active interest in the more modern developments of astronomy, in which he is already distinguished.

The future of the Royal Observatory is a subject on which the mind of Sir George Airy often exercised itself, and to which he alluded more than once in his Reports to the Board of Visitors. With his fundamental proposition that observational astronomy, in its bearing on the improvement of navigation, must always be its main line of work, every one must agree. Over and above this, the expressed wish of the Board of Visitors, and the practice of the last few years, have already sanctioned the addition to the ancient duties of the Observatory of some of those long and systematic series of observations, such as that of the solar protuberances, and the motion of the fixed stars in the line of sight as shown by the spectroscope, which are beyond the scope of an amateur, and above the power of any individual astronomer, however devoted to his work, to permanently maintain. How far it may be desirable to continue magnetic and meteorological observations beyond the necessities of an astronomical observatory, are questions which will doubtless engage the attention of the present director. The main question must be, What distribution of these branches of study among Greenwich, Kew, and other establishments, will in the end best conduce to the progress of science? And with a view of giving full scope to the judgment and skill of the present and future holders of the office the Board of Admiralty have, as I understand, decided to consider a revision of the terms of the Royal Warrant under which the appointment is made.

This year has been signalised by the meeting of a most important scientific congress—the International Congress of Electricians, held at Paris. The recent developments of the practical applications of electricity rendered the occasion favourable both for organising a special exhibition devoted solely to this branch of science, and also for assembling the electricians of all countries.

The general purpose of this Congress was to discuss, and if possible to settle, some of the numerous difficulties which perplex both the physicist in his studies and the constructor in his work.

But chief among the subjects proposed to, and undertaken by, the Congress was that of fixing a system of electrical measures for international adoption.

Perhaps in no subject is the necessity of uniform system of standards so striking as in electricity. This science, both in its practical applications, such as telegraphy, and in the great natural problems of terrestrial magnetism and atmospheric electricity, refuses to recognise any artificial divisions of the surface of the globe, whether ethnological or political. It rarely happens, in operations undertaken on so large a scale as the study of electricity and its industrial applications, that an opportunity presents itself of arranging for concerted and harmonious action through a period extending to a distant future. Before a branch of industry has attained sufficient importance to claim international recognition, it has usually gone through the process of considerable development in different countries; and in each of these developments it has often received a stamp of local character which makes it difficult to reduce the whole to one uniform system. But in the case of electricity there were fortunately present special circumstances which facilitated the adoption of uniform standards. Foremost among these was the fact that the development of its practical applications, in other departments than telegraphy, were so recent that it was not too late to legislate for it as though it were but just about to begin. Secondly, the international character of telegraphy, and the fact that the manufacture of its apparatus had always been confined to the great centres of civilisation, had both tended to limit the number of existing systems of measurement, and prevented that multiplicity of standards which would certainly have arisen had such manufacture been carried on in numerous and in isolated localities. But by far the most important influencing circumstance was the happy idea due to the British Association of adopting standards based on absolute measures. The Association did not allow the idea to remain barren; but, through the instrumentality of its Committee on Electrical Standards, it gave to the world the admirable units of the Ohm, the Volt, and the now re-christened Weber; and the eminent men who formed that Committee may now point with honourable satisfaction to the fact that the Electrical Congress decided unanimously to recommend for universal acceptance those units which that Committee so early adopted.

With the single exception of the unit of current which, in order to avoid an ambiguity in the signification of Weber, receives the title of Ampère, the names are left substantially without change.

The adoption of these units for international use is to be preceded by a new and more careful redetermination of the ohm at the hands of the great physicists of all nations. And it is intended that this redetermination shall result in a standard for general adoption. Thus electricity will be the first of the practical sciences to be freed from all difficulties due to local standards; and it is to be hoped that this example may be followed in other sciences concerned with practical life.

The following are the actual resolutions adopted by the International Congress of Electricians at the sitting of September 22, 1881:—

1. For electrical measurements, the fundamental units, the centimetre (for length), the gramme (for mass), and the second (for time), are adopted.

2. The ohm and the volt (for practical measures of resistance and of electromotive force or potential) are to keep their existing definitions, 10^9 for the ohm, and 10^8 for the volt.

3. The ohm is to be represented by a column of mercury of a square millimetre section at the temperature of zero Centigrade.

4. An international commission is to be appointed to determine, for practical purposes, by fresh experiments, the length of a column of mercury of a square millimetre section which is to represent the ohm.

5. The current produced by a Volt through an Ohm is to be called an Ampère.

6. The quantity of electricity given by an Ampère in a second is to be called a Coulomb.

7. The capacity defined by the condition that a Coulomb charges it to the potential of a Volt is to be called a Farad.

The remainder of the work of the Congress consisted mainly of the discussion of various interesting questions bearing upon electricity; and although these did not in many cases issue in precise recommendations, yet they were not altogether devoid of practical results. The questions which chiefly attracted its attention were those of terrestrial magnetism and earth-currents, atmospheric electricity, and the more practical but perplexing question of lightning conductors. In all these matters the need of close and continuous intercourse between the observers of different nations was strongly felt; and the Congress passed resolutions recommending combined action both in the way of observations carried on simultaneously and with like apparatus, and also of frequent if not continuous telegraphic communication of the results of these observations. The organisation of so extensive and perhaps so costly a system of combined observations must depend to a great extent on the various Governments, and also on the goodwill and generosity of the great telegraphic companies; but it is much to be wished, for the sake of science, that some progress in that direction may soon be effected. The present state and prospects of electro-physiology also received careful discussion, but the difficulties of the subject precluded any definite conclusions. The same was the case with the question of photometry as applied to the intense light with which electricity furnishes us. Resolutions recommending the adoption of certain provisional photometric standards were passed; but these only evidenced the strong feeling that prevailed in the Congress, that some new departure must be made, and that a new standard of illumination (such as perhaps the glow of platinum on the point of fusion) must eventually be adopted for electric lights.

I have described the more important of the results of the

deliberations of the Congress. Perhaps, however, the most important of all (with the exception of the choice of electrical units) will prove to have been the impetus given to electrical science by the interchange of ideas that took place among the leading physicists of all nations, and the light that was thrown on the various problems which came under discussion in the meetings of the Congress.

I cannot conclude this imperfect sketch of this important Congress better than by quoting the eloquent words of M. Dumas at the conclusion of its sittings: "Greek mythology, in its happy personification of the forces of nature, placed the winds and the waves under the direction of divinities of the second rank; it made the celestial representative of light its god of poetry and of the arts; and by an admirable forethought, it reserved lightning for Jupiter. Science and industry have long since laid their hands on the forces which air and water have placed at the disposition of man. Steam, animated by fire, has enabled him to overcome many obstacles and to rule the waves. Light has no longer any secrets from science, and the arts are daily multiplying its marvellous applications. But there remained one labour to accomplish: namely, to wrest lightning itself from the hands of the ruler of the gods, and to bend it to the needs of humanity. This is the feat which the nineteenth century has now accomplished, and of which this Congress is the evidence and the witness. This feat will mark an epoch ever memorable in history; and, amid the turmoil of politics and of questions which agitate the human mind, it will be recognised as the characteristic feature of our era. The nineteenth century will be the century of electricity."

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following is the speech delivered in the Senate House on November 24 by the Public Orator (Mr. J. E. Sandys, Fellow and Tutor of St. John's) in presenting Dr. Thomas Sterry Hunt for the Honorary Degree of LL.D.:—

"Dignissime domine, domine Procancellarie, et tota Academia:

"Scientiam illam Geologicam, quae, in orbis terrarum origine et natura investiganda, neque temporis finibus terminatur neque saeculorum spatio coercetur, nos certe pro rei magnitudine, temporis praesertim angustiis impediti, orationis brevissimae intra spatium laudare non possumus. Iuvat potius hodie scientiae tam magnae professorem insignem vestro omnium nomine salutare, qui in republica illa maxima trans Atlanticum natus, nostrae tamen, provinciae Canadensis rupibus explorandis quinque et viginti annos dedicavit; qui de omnium animantium (ut nonnullis videtur) antiquissimo, quod Eozoon Canadense nuncupatur, doctissime disputavit; qui (ne plura commemorem) non modo vetustissimorum illorum saxorum, quae Laurentia nominantur, sed aliorum quoque complurium originem primam vicesque varias sagacissime investigavit. Quid autem si, in tot tantisque argumentis totiens retractandis, non semper sibi constare, non semper eadem sentire, visus est? Vos certe ex Academicae philosophiae disciplina didicistis, virum vere sapientem (ut Ciceronis nostri verbis utar) 'quod dixerit, interdum, si ita rectius sit, mutare; de sententia discedere aliquando.' Ceterum idem necessitudinis vinculo in perpetuum duraturo nobiscum idcirco coniunctus est, quod professoris illius nostri, qui has inter umbras plusquam quinquaginta annos studiis Geologicis lumen praetulit, et interpres et defensor egregius exstitit. O utinam hospiti nostro, nuper ex Italia ad nos advecto, mox autem, favente (uti par est) Neptuno suo, in patriam transituro, inter tot aedificia variis doctrinae studiis consecrata, novum illud Museum quod Nestoris illius nostri sempiternum fore monumentum iamdudum exspectamus, si non ad ipsum finem adductum, at inchoatum certe ostendere potuissemus. Ipsi meministis veteris poetae monitum illud:

"'Gratia ab officio quod mora tardat abest';

vestrum igitur officium est, viri Academici, qui beneficiorum tantorum non immemores estis, monumentum illud magnum ad exitum felicem quam maturissime perducere; nos interim nostro qualicunque laudis officio perfuncti, plausus illos vestros, qui hospiti nostro iam diu debentur, non iam amplius morabimur.

"Ergo vobis praesento Regiae Societatis Londinensis Socium, virum de studiis Geologicis optime meritum, Thomam Sterry Hunt."

OXFORD.—The Brackenbury Natural Science Scholarship at Balliol College has been awarded to Mr. T. F. McArthur, of Manchester Grammar School. *Proxime accessit*, Mr. J. J. Hart, Exhibitioner of the College. The following gentlemen distinguished themselves in the examination:—Mr. A. Ford Smith, Bedford Modern School; Mr. A. Wentworth Jones, Clifton College; and Mr. P. Hawkridge, Derby School. Mr. Ford Smith was elected to a Natural Science Exhibition.

The Statute respecting the inspection and licensing of lodging-houses was finally passed by Congregation on November 23. The following clauses were inserted concerning the duties of the Controller of Lodging-Houses and the Sanitary Inspector:—

"The Controller shall inspect every house proposed to be licensed for the residence of Undergraduates; he shall also visit, with or without notice, every licensed house once at least in each year, and report thereon to the Delegates.

"There shall be a Sanitary Officer appointed by the Delegates, for such period and under such conditions as they may determine. He shall inspect every house proposed to be licensed for the residence of Undergraduates, and shall make a Report to the Delegates on the sanitary condition of each house thus inspected. He shall also visit each licensed lodging-house once at least in every year, and any licensed lodging-house at any time by the order of the Delegates. The stipend of the Sanitary officer shall be determined by the Delegates in conjunction with the Curators of the University Chest.

"The Delegates may obtain, when occasion shall arise, additional advice, whether medical or of any other professsional kind. Any person whom they may thus employ shall receive such fee as shall be agreed on by the Delegates in conjunction with the Curators of the University Chest."

SOCIETIES AND ACADEMIES

LONDON

Meteorological Society, November 16.—Mr. G. J. Symons, F.R.S., president, in the chair.—Twenty-seven gentlemen were elected Fellows of the Society.—The evening was devoted to an account of the gale which passed across the British Isles, October 13-14, 1881, which had been prepared by Mr. G. J. Symons, F.R.S., with the assistance and co operation of Mr. C. Harding and other gentlemen. There is evidence of the storm being formed in the Atlantic, about 150 miles south of Nova Scotia on October 10, and that at noon on the 13th there was a considerable disturbance about 600 miles west of Galway. At that time there were scarcely any instrumental indications in the British Isles of the coming storm; the barometer was falling at Valentia, but not rapidly, and at some of the western English stations it was rising. The curves of barometric fluctuation show very plainly the advance of the depression from west to east, for while at Valentia the minimum occurred at 2 a.m. on the 14th, on the east coast of Norfolk it is recorded that it did not occur till 4 p.m. This fact, coupled with others, seems to indicate an easterly progression of the barometric minimum at nearly forty miles per hour. As far as the sea is concerned, the chief force of the gale was felt on the afternoon of the 14th in the German Ocean, and there the great loss of life and destruction to shipping seems mainly due to the exceptionally violent squalls which were peculiar to this gale, as well as to the extremely sudden manner in which the wind increased to hurricane force. The afternoon became quite darkened by the salt water blown into the air, so that it was impossible to see a ship's length ahead. The barometric chart for 9 a.m. on the 14th showed that the pressure in the north of England was an inch lower than in the south, and nearly two inches lower than in the South of France. The area over which injury was produced was very large, and although not without precedent, it was happily rare. The record of 56 lbs. per square foot at the Royal Observatory, Greenwich, was the highest ever registered in that locality, and close by thirty-five trees were blown down in the park, and fifteen feet blown off the top of a spire which had been erected about forty years, the stone of which shows no sign of decay, and which had retained its position almost, if not wholly, by the gravitation of its mass. The general opinion seems to be that the structural damage over the greater part of the country was by no means unprecedented, and in the greater part of Ireland and the south-west of England was not even of an unusual character; but along the east coast and in the East Midlands the damage was excessive, and on the north-east coast unprecedented. In Scotland the destruction of trees was enormous.—Mr. J. Wallace Peggs, F.M.S., also read a paper on the structural damage caused by the gale as indicative of wind force, and remarked that since the

Tay Bridge disaster attention had once more been directed to the subject of wind pressure. He suggested that a conference of delegates from societies specially interested in the subject should be held, who should make experiments and carefully consider the whole question.

Entomological Society, November 2.—H. T. Stainton, F.R.S., president, in the chair.—Exhibitions: An aberration of *Urapteryx sambucaria*, L., Mr. C. O. Waterhouse.—A new species of *Antheræa* from the Gold Coast; and some microscopic preparations of the saws, &c., of various *Hymenoptera*, prepared by Mr. P. Cameron of Glasgow, Mr. W. F. Kirby.—Pieces of honeycomb constructed on a bare wall, without any protection; and specimens and figures of new varieties of *Armadillium vulgare*, L., and *Porcellio scaber*, Latr., Rev. A. E. Eaton.—A specimen of *Lycæna icarus*, Rott., var *Icarinus*, Scriba, Dr. H. G. Lang.—An undescribed species of *Cicadidæ* from Borneo, with unusually developed opercula, Mr. W. L. Distant.—A female specimen of *Dufourea minuta*, Lep., Mr. T. R. Billups.—A specimen of *Scleroderma domestica*, Westw.; the larva was found parasitic on that of a Longicorn beetle in a pine-tree at Lyons; and some *Diptera* which attack figs in Turkey and Egypt, Sir S. S. Saunders (this led to an interesting discussion on fig-parasites and caprification).—Some remarkable tubes formed by Lepidopterous larvæ at Aden; and a specimen of *Cerura vinula*, L., which it was thought at first might belong to *C. erminea*, Esp., the President.—Papers read: Descriptions of new genera and species of Heterocerous *Lepidoptera* from Japan (concluded), by Mr. A. G. Butler; and a memoir on the various Dipterous insects (*Muscidæ* and *Tipulidæ*) destructive to cereals in Britain, by Prof. Westwood.

Geological Society, November 2.—R. Etheridge, F.R.S., president, in the chair.—Richard Paley Gardner, Henry Neville Hutchinson, Henry Johnson, William Regester, and George Tate, Ph.D., were elected Fellows of the Society.—The following communications were read: On the genus *Stoliczkaria*, Dunc., and its distinctness from *Parkeria*, Carp. and Brady, by Prof. P. Martin Duncan, M.B. Lond., F.R.S., F.G.S., Pres.R.M.S.—On the elasticity- and strength-constants of Japanese rocks, by Thomas Gray, B.Sc., F.R.S.E., and John Milne, F.G.S.—The glacial deposits of West Cumberland, by J. D. Kendall, C.E., F.G.S.

EDINBURGH

Royal Society, November 28.—The following were elected office-bearers, viz.:—President, the Right Hon. Lord Moncreiff; Vice-presidents: David Milne Home, LL.D., Sir C. Wyville Thomson, LL.D., Prof. Douglas Maclagan, M.D., Prof. H. C. Fleeming Jenkin, F.R.S., Rev. W. Lindsay Alexander, D.D., J. H. Balfour, M.D., F.R.S.; General Secretary, Prof. Tait; Secretaries to ordinary meetings: Prof. Turner, Prof. Crum Brown; Treasurer, Adam Gillies Smith, C.A.; Curator of Library and Museum, Alexander Buchan, M.A.; Members of Council: Prof. Campbell Fraser, Prof. Geikie, Rev. Dr. Cazenove, David Stevenson, Prof. Chrystal, Sheriff Forbes Irvine, Prof. A. Dickson, the Right Rev. Bishop Cotterill, Rev. Prof. Duns, Dr. Ramsay Traquair, John Murray, William Ferguson.

PARIS

Academy of Sciences, November 21.—M. Wurtz in the chair.—The following papers were read: On the condition of achromatism in phenomena of interference, by M. Cornu. In a system of fringes of interferences produced with heterogenous light having a continuous spectrum there is always an achromatic fringe which plays the *rôle* of central fringe, and is found at that point of the field where the most intense radiations present a maximum or minimum difference of phase. M. Cornu indicates the properties of the achromatic line, and shows the inaccuracy of the accepted theory for determination of the central fringe.—Reactions of salts of gallium, by M. Lecoq de Boisbaudran.—On a bed of reindeer remains near Paris, by M. Gaudry. This bed was found by M. Vasseur at Montreuil, and the remains have been sent to the Museum. They comprise, with numerous bones of reindeer, remains of elephant, rhinoceros, horse, bison, freshwater shells, &c. The deposit (which is surmounted by beds of grey sand and mud) is supposed to belong to the great glacial epoch of boulder-clay. M. Gaudry is enabled to sketch the history of quaternary times in the Parisian basin.—Observations on the *rôle* of faults in the geological structure of the Western Alps, by M. Lory. Some large fractures can be traced continuously right through Dauphiné, Savoy, and Valais, producing longitudinal zones with different orographic characters and strata.—On the crystallisation of sulphides of cadmium and zinc, by M. Hautefeuille.—On the agreement of the curve of solar spots with the actions resulting from the eccentric motion of large planets, by M. Duponchel. Reviewing the observations collected by Wolf from 1608 to our time, he finds the mean period of the oscillations not 11·2 years, but 11·86, the time of a revolution of Jupiter, with which it seems really connected. The perturbations of the curve are distinctly *en rapport* with the times of revolution of the three large superior planets.—On the winter egg of phylloxera, by M. de Lafitte.—Elements of the orbit and ephemerides of the planet (217) Endore, by M. Callandreau. On some series for the development of functions with a single variable, by M. Halphen.—On a particular curve of the third order and on certain uniform functions of two independent variables, by M. Picard.—New method of dividing the circle into equal parts, by M. Pellet.—Integration of differential equations of the vibratory motion of a spherical bell, by M. Mathieu.—Numerical application of the theory of maximum yield of two dynamo-electric machines employed for transport of force, by M. Lévy. Referring to a case discussed by M. Deprez, he shows that, by adopting different resistances, he would obtain 10 horse-power at 50 km., with a maximum electromotive force of 5356 volts, instead of about 7000.—On M. Lippmann's method for determination of the ohm, by M. Brillouin.—Remarks on the electrolysis of water, by M. Tommasi. In decomposing water with a single element, copper wire being used as positive electrode, and platinum wire as negative, the quantity of copper dissolved is greater than the quantity deposited on the negative electrode; and this is explained by the thermal theory.—On the dif rmine of glycerine, by M. Van Romburgh.—On some spectral reactions of alkaloids and glucosides, by M. Hock.—Electric current produced by light, by M. Laur. Light affects the American process of amalgamation in Mexico. The author elucidated the action by experiments which reproduce, in complex form, effects that have been indicated by M. Edm. Becquerel (as that physicist pointed out).—On some new cases of phosphorescence in plants, by M. Crié. He lately observed *Auricularia phosphorea* and *Polyporus citrinus* to emit luminous radiations; also *Rhizomorpha* or the vegetative apparatus of many champignons; also *Xylaria polymorpha*. This is the first time emission of light has been observed in Ascomycetes.—Influence of the nature of food on sexuality, by M. Yung. He fed separate sets of tadpoles with fish, meat, coagulated albumen of hens' eggs, yellow of eggs, and with a mixed diet. These aliments do not appear to have a very distinct influence on the sex; but along with M. Born's experiments, those of M. Yung support the idea that a special diet afforded to young tadpoles from the time of leaving the egg, favours the development of a female genital gland.—Development of the egg of Melicerta, by M. Joliet.—On spermatogenesis in Selachians, by M. Hermann.—M. Hément communicated some further observations on the articulation of deaf mutes.—M. Daubrée presented an Italian work by Prof. Cossa, "Chemical and Mineralogical Researches on the Rocks and Minerals of Italy."

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THURSDAY, DECEMBER 8, 1881

SMOKE-ABATEMENT EXHIBITION

ON the 30th ult. an exhibition was opened at South Kensington of appliances intended to prevent excessive production of smoke in household grates and in the furnaces and boilers of manufactories, and thus to remove from the fogs of great cities, and especially of London, one of their most offensive constituents, and that which is most potent in darkening the cities over which they spread themselves. The Exhibition is described as "international"; that title is, however, often given on rather a slender basis; and from what we can at present see, the main exhibits are British, although a few interesting objects are sent from Germany, Canada, and France.

The origin of the Committee, which has for the last eight months systematically endeavoured to direct the minds of Londoners to the question of bringing into practical use some means of lessening the smokiness of London, if not rendering London smokeless, is described in the official Report as follows; and as it may be hoped that this Exhibition is only the beginning of a movement of which, with the aid of perseverance, energy, and scientific ingenuity, much may be expected, it is interesting to place the history of the movement upon record.

"The subject of the abatement of smoke, with the view of purifying the atmosphere of London and lessening the deleterious character of London fogs, has been vigorously taken up by the National Health Society during the past year. In the spring of 1880 the subject was brought under the notice of the Committee by Mr. Ernest Hart, the Chairman of Council, as one which he was desirous of taking up actively, with the co-operation of the Committee, and he was requested to take steps to bring the question into a practical form for further proceeding. With this view Mr. Hart placed himself in communication with Prof. Chandler Roberts, F.R.S., Professor of Metallurgy at the School of Mines and Chemist to the Mint, who undertook to make an examination of existing methods of combustion of coal in household grates and in furnaces. Further steps were taken to obtain details of the existing apparatus in use in different parts of the kingdom, and a considerable collection of documents was made, which have been placed at the disposal of the Committee subsequently formed. In July Mr. Hart learned from Miss Octavia Hill, the Treasurer of the Kyrle Society, that that Society was contemplating some action in the like direction, and it was arranged between Miss Hill and Mr. Hart, that with the approval of the respective societies a joint committee should be formed, with the object of continuing the movement. Such a committee was accordingly nominated, and met at the National Health Society's rooms; a definite course of proceeding was resolved on, and a programme was sketched out. Various eminent persons known to be specially informed on the subject (not all connected with either Society) were asked to join the Committee."

Among those who have given most active assistance are Dr. Siemens, Capt. Douglas Galton, Mr. Atchison, and Col. Festing, R.E.; but it is needless to say that all the eminent persons in art, literature, and science who have been asked to join have willingly given the valuable aid of their names, so that the Committee is a very representative one. The Exhibition includes a great variety of exhibits divided into the following sections:—

In *Section A.* will be found: Open coal-fire grates, stoves of all kinds, kitcheners, kitchen ranges, draught-regulators, base burners, and other appliances devised to prevent the liberation of smoke from bituminous coals or to consume anthracite and other smokeless fuel.

Section B.—Gas fires, open grates and stoves, gas producers, and gas-heating apparatus of all kinds for domestic use.

Section C.—Appliances for heating rooms and buildings by hot air, hot water, and steam circulation.

Section D.—Gas engines, boiler furnaces, fire-bars, mechanical stokers, smoke-preventing furnace bridges, and other appliances for steam-engines and for general industrial purposes.

Section E.—Anthracite and other smokeless coals, bituminous and semi-bituminous coals, patent and other fuels.

Section F.—All foreign exhibits. Improvements in chimney flues, ventilating apparatus, and novel inventions for regulating temperature, &c.

Buildings have been fitted up for the purpose of testing the efficiency of grates, stoves, and other appliances suited for domestic use; and trials of various fuels and boiler appliances will also be conducted in the Exhibition Buildings, and at certain factories where facilities have been offered by the proprietors.

The Committee have secured the services of Mr. D. Kinnear Clark, M. Inst. C.E., to superintend the trials under the direction of the Executive Committee. In conjunction with Dr. Frankland, F.R.S., Prof. W. Chandler Roberts, F.R.S., has undertaken to make certain chemical tests in connection with the trials of fuel grates and stoves.

It is not unreasonable to expect that such an exhibition carried out under the direction of a Committee of Experts, which includes Prof. Abel, C.B., Royal Arsenal, Woolwich, A. T. Atchison, M.A., William R. E. Coles (Hon. Secretary), Col. E. R. Festing, R.E. (Science and Art Department, South Kensington), Capt. Douglas Galton, C.B., F.R.S., Prof. Edward Frankland, LL.D., F.R.S. (School of Mines, South Kensington), Sir Ughtred Kay-Shuttleworth, Bart., Dr. Siemens, F.R.S., LL.D., J. Lowry Whittle, Temple, will be of national value. It will tend directly to a better utilisation of coal and coal products, by determining practically and scientifically the means which are actually available for heating houses as at present (and as may be) constructed without producing smoke, as the Committee will be enabled to examine the subject generally and to report for public information upon the relative adaptability of the various coals and appliances to the requirements of every class of the community. Trustworthy information will be obtained upon which to base sufficient and equitable amendments of the existing laws regarding smoke; and the Committee will also ascertain and make known the comparative value of existing appliances for the utilisation of gas for the purpose of heating.

It must be admitted that for years past the air of London has steadily deteriorated, and that in London, which 150 years ago was famous for its roses, it is now impossible to get a rose to blossom or conifers to grow. Homely but practical evidence of the actinic influence of light, which is so essential to the health of plants

and animals, was given by Mr. Ernest Hart at one of the many meetings which have been held on the subject, when he mentioned that wax manufacture had been, during the last twenty years, successively driven further and further from the centre of London. Ten years ago it was possible to bleach wax in the sunlight at Shepherd's Bush, but the factory was now removed to near Richmond, as it was found that the bleaching power of the sun for the greater part of the year was almost nullified by the pall of smoke which hangs over the metropolis. We shall not speak to-day of the various appliances of which we have as yet had but a hasty view, but it is only fair to say that there are shown at the Exhibition a number of grates, some of which, such as the new "Everitt" grate shown by Messrs. Barnard, Bishop, and Barnard; Mr. Crane's grate, shown by Deane and Co.; and in some respects the "Excelsior" grate of Mr. Archibald Smith, mark distinct advance. The possibility of consuming the smoke of bituminous coal in ordinary grates by forcing the draught of air and smoke downward through the fire before it is allowed to escape has been shown, as has also the facility with which hard anthracite smokeless coal will burn in open grates without any sort of blower or other such contrivance. In addition to these there is an extremely interesting series of exhibits of mechanical stokers, fire-bars for furnaces, a new gas-kiln which will be shown in operation, as well as Dr. Siemens' gas-regenerator. Some extremely good household stoves and fire-places are sent from Germany and Canada.

DOUBLE-STARS

Observations of Double-Stars made at the United States Naval Observatory. By Asaph Hall, Professor of Mathematics, United States Navy, and Rear-Admiral Rodgers, U.S.N., Superintendent. (Washington: Government Printing Office, 1881.)

WE welcome another addition to our knowledge of the positions and distances of double stars. Prof. Asaph Hall has published a volume containing 1614 observations of such stars made by him chiefly with the 26-inch refractor at the Naval Observatory at Washington. The objects of the observations are two. Firstly, the detection of constant errors of observations by the measurements of double-stars from a selected list, and comparing such measures with those of other observers made as nearly as possible simultaneously; and, secondly, the measurements of double-stars generally.

The list of stars adopted is that prepared by Otto Struve, with a few additions of stars of greater distance. There are 30 stars in all, and 296 complete sets of measures of these have been made, each set consisting of four measures of position and two double measures of distance, except in cases where the stars exceed 3″ in distance, when four were taken. The measures appear to be made with care, and the discrepancies are not greater than may be expected from night to night.

In connection with this subject Prof. Hall has applied a geometrical test to such observations by means of measures of the multiple stars Σ 2703 and Σ 311 and the stars in the trapezium of Orion. He says:—

"In the case of three stars A, B, C, if we take the origin of co-ordinates at A, and observe the angles of position and the distances of B and C only, then these quantities are independent, and we may put their differentials equal to zero. But if we observe also the angle of position and the distance between B and C we have obtained more quantities than the geometrical conditions require, and must adjust the parts of the triangle by the method of least squares."

In the case of the triangles and the quadrilateral there appear to be no important systematic errors.

Prof. Hall gives a detailed account of the use of "rough circles" for setting the instrument on a star. These circles are the edges of the ordinary setting circles divided by lines of black paint on a white ground so as to be read without trouble, a method already adopted in some observatories in this country. He also describes the difficulties he has had with the driving clock, difficulties which are too often experienced with driving clocks of all kinds, and often arising from insufficiency of power and strength of parts to stand varying strains, and often dust and damp, which ordinary clocks do not generally experience. The dome, which is 42 feet in diameter, now turns with more difficulty, and if our experience is worth anything, such a difficulty once commenced will keep on fast increasing, and will very materially militate against the continued use of the instrument beneath it. The flexure of the telescope, which is 31 feet in length, and of the mounting, is small, and the working of the instrument very satisfactory.

A filar micrometer has been used for all the observations, and great care has been taken to test its accuracy, which is all that can be desired; but we note that the wires are illuminated by a lamp held by an assistant, a method somewhat primitive, as Prof. Hall says, and a waste of energy which might, we should have thought, have been useful elsewhere.

In all the ordinary observations four measures of position and two double measures of distances have been taken, and in all cases the head of the observer was kept in an upright or natural position. Owing to this we shall expect to find, on comparison of the list of test stars with others, a considerable error depending on the position of the stars with the horizon. No doubt practice has a great deal to do with it, but we have generally understood that the observations were more accurate and differed less *inter se* when made with line joining the eyes parallel to that joining the stars under observation.

Prof. Hall has included a good many very close stars, and it is to them that the large telescope can be most profitably turned, leaving the wider ones for the small instruments, with which they are well able to deal.

OUR BOOK SHELF

Zoological Atlas (including Comparative Anatomy), with Practical Directions and Explanatory Text for the Use of Students. Invertebrata. By D. M'Alpine. 249 Coloured Figures and Diagrams. (Edinburgh and London: W. and A. K. Johnston, 1881.)

THIS Atlas is prefaced by the following remarks:—"In treating of the Invertebrata I have thought it advisable to depart slightly from the plan followed with the Vertebrata. There are five great divisions of Vertebrates recognised by naturalists, and a type or so of each was found to answer the purpose in view; but among Invertebrates the range of structure is immensely greater, and

the typical forms are thereby necessarily increased. In order to preserve the just proportions of the subject, and out of the whole make a fair selection, I have treated most of the forms in less detail than the Vertebrates." With the above statement no objection could be found; as to the method of carrying it out, we notice that while four out of the sixteen plates are devoted to illustrations of the group of Protozoa, there is not even a single figure given of the Sponges, nor of the Hydrozoa, nor of the Actinozoa, and for their absence we can find no other excuse than what is given in the above quotation. As to the plates of Protozoa, we perceive that there is no exact indication of the size of the forms figured, unless indeed in a footnote, which states that the forms figured "are all *microscopic*, with the exception of the Nummulites." Now if there is one thing more than another that a student requires to be reminded of while studying "microscopic" forms, it is that they vary immensely among themselves as to size, and it is surely necessary that he should have some definite ideas as to those sizes beyond the range of unassisted vision, such as he may be presumed to have of those objects within this range. Neither has the author been to our mind happy in his selection of forms of the Protozoa "from standard works on the subject." His Atlas is meant for students in this country, and where are they to get specimens to work with of such genera as Protogenes, Vampyrella, Myxastrum, Protomonas, Protomyxa, Lieberkühnia, and the like. The student interested in "pond-life" may possibly admire the exquisite and artistic delineations of their old favourites, *Paramœcium*, *Daphnia*, *Cyclops*, &c., given in the Atlas. The festooned surface of *Paramœcium*, the appendages of *Daphnia* and *Cyclops* are certainly figured as they have never been heretofore. It is really refreshing to turn from the old and well-worn figures to the bold originality of these plates; in them the author has courageously followed the theory of zoological representation laid down by the celebrated German artist with reference to *Camelus*, sp., but is scarcely to be congratulated on the wonderful results he has achieved. Some of the diagrams are acknowledged as from the originals of Huxley and Gegenbaur; these are good.

The Student's Handbook of Chemistry. With Tables and Chemical Calculations. By H. Leicester Greville, F.I.C., F.C.S. (Edinburgh: E. and S. Livingstone, 1881.)

"In the presence of so many good manuals on chemistry, the appearance of another may seem unnecessary," says the author in his preface. For "may seem" read "is," and the sentence expresses a truism. The author's book can, however, scarcely be classed amongst "good manuals." The statements of individual chemical facts are on the whole correct; the general arrangement of the book is clear; yet, considered as a manual of chemistry, the work must be pronounced a failure.

Attempts are made to explain the expressions "atomic weight," "molecular weight," "valency," &c., but without success. Atoms are confused with molecules; the ordinary definitions of these terms are certainly stated, but definitions taken by themselves are, as Hunter said, "Of all things on the face of this earth the most cursed."

Avogadro's law is stated on p. 26, but the conclusion deduced therefrom, viz. "the densities of all the elementary bodies in the gaseous condition are the same as their respective atomic weights, or, the atoms of all the elements in the gaseous state occupy the same space," is untrue, and does not follow from the generalisation of Avogadro.

The Daltonian atomic theory is stated much in the terms which might have been employed before the molecular theory of matter had been propounded. Such statements as that on p. 15, that oxides are called monoxides, dioxides, &c., according "as the compounds contain one, two, three, &c., atoms of oxygen respectively"; or that on p. 13, "that acids are spoken of as monobasic, &c., according as they contain one, two, &c., atoms of hydrogen replaceable by a base," show that the author has failed to grasp the teachings of the molecular theory.

The term "valency," we are told on p. 159, is used to express "the comparative saturating power of the different elements, taking hydrogen as the unit." Such a loose statement as this naturally prepares the way for the full acceptance of the "bond" view of valency, with all its inconsistencies and apparent, but unreal, explanations of facts; so that one need not be surprised to find (p. 160) the expression, hard to be understood by the uninitiated, "the affinity of these bonds."

A sentence on p. 161 may be quoted as a type of the kind of writing to be found in the works of those who are bound by the trammels of this pernicious system. "The disappearance of the active atomicity by twos, which is found to be always the case, has led Dr. Frankland to suggest that the bonds of union so disappearing are engaged in satisfying each other."

That part of the chapter on "The Higher Principles of Chemical Philosophy" which deals with compound radicles is equally unsatisfactory. Sulphuric acid may be assumed to contain the radicle SO_2. "The group SO_2 may be traced all through the compounds of sulphuric acid, thus: $SO_2(OK)_2$ $SO_2(ONa)_2$ SO_2CuO_2." Such a statement is harmful, and only harmful, to the student; in what light other than as an amusing plaything can he regard this conception of compound radicle? Why should he not trace the group SO_3, or the group SO, or the group SO_4 "all through the compounds of sulphuric acid"? Give him pen and paper, and if he have a little fancy he will trace you a most varied and pleasing number of groups "all through" as many compounds as you please.

The tabulation of facts concerning groups of elements and compounds is a good feature in this book, and likely to prove very useful to the student. The chapters dealing with organic chemistry are clear and succinct: had the author contented himself with recording leading facts, and left the "principles of chemical philosophy" alone, he would have produced a book of some merit, although not of merit sufficient to warrant him in adding another "Manual of Chemistry" to the list which is already so much too long.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The "Eira" Arctic Expedition

Those who advocate the despatch of a Government vessel in search of Mr. B. Leigh Smith's expedition betray only a partial acquaintance with the circumstances of the case. His having failed to return this season is no evidence whatsoever of his having met with disaster; for previous to his departure from England, certain people well understood that he was prepared to spend the present winter far north if he found it worth while to do so. It was this which prevented me from going with him (natural history work on hand precluding my absence from London for upwards of a year); for as I had collected plants and animals with him on a former expedition in Spitzbergen, he invited me to accompany him on his present trip to Franz-Josef Land. The *Eira* was well-provisioned for upwards of eighteen months, and in summer time fresh meat in abundance can be secured, which, hung up in the rigging, will keep good for almost an indefinitely long period. Thus the expedition has provisions enough for at least another year and a half from the present time, and there would be no need for them to starve two years hence. It is therefore rather

early to begin to feel uneasy about their safety on account of provisions.

The detention of the *Eira* in the north is more probably due to her being "beset" than to her having been "nipped" or run aground. Unless she has foundered before stores could be got out of her (when nothing could be done by any search-expedition towards enabling the crew to survive the winter), Mr. Smith and his men are doubtless having a fine time of it up there, in one sense of the words. If it came to the worst they would not be obliged to abandon the ship simply on account of her being hopelessly "beset," until the spring of 1883, because they could afford to wait for the chance of her being liberated next summer or autumn. Then, if she were clearly inextricable, they would do what is done by the crews of whalers under similar circumstances—haul boats or sledges, laden with provisions, over the ice to some place where, in the ordinary course of events, they could not fail to fall in with walrus-hunters, or from whence they might take a departure in their own boats to the most convenient country. Mr. Smith, to my personal knowledge, always counted upon being able to effect a safe retreat by these means, without unusual difficulty, if he should lose his ship: the despatch of an expedition from England in search of him never entered into his calculations. This will amply account for his not naming a *rendezvous*. In the Arctic regions it is best not to be tied down beforehand to any one *route* where there is a choice of several, lest if emergency arise it prove to be *pro tem.* precisely the most difficult of all.

In view of the above facts it appears premature to demand the equipment of a vessel to rescue the *Eira* as a matter of immediate urgency, although, if nothing be heard of her by this time next year, an expedition during the season of 1883 might be a reasonable precaution by no means uncalled for. If people want a ship to be sent out next year, why should not the agitation be an honest one for an Arctic expedition pure and simple?

Thorncombe Vicarage, Chard, Dec. 3 A. E. EATON

Helophyton Williamsonis

AT the late York meeting of the British Association two of my indefatigable auxiliaries in the work of Carboniferous investigation, Mr. Wm. Cash, F.G.S., of Halifax, and Mr. Thomas Hick, M.A., B.Sc., of Harrogate, described, under the name of *Hymenophylloides Williamsonis*, a new stem of a plant, which they had obtained from the Halifax beds. This plant is an extremely interesting one, since its cortical layer exhibits the large, open, longitudinal lacunæ, formed by dissociation, so common amongst aquatic plants. It is still more interesting since the septa separating the large lacunæ are rotate, each one consisting of a single layer of cells, and the whole combining to constitute a network with vertically elongated meshes. This arrangement approaches too closely to that seen in the living Marsileaceæ, to be overlooked in considering the possible affinities which it may indicate. The structure of the central vascular bundle as well as of its component vessels differs decidedly from that of the recent Marsileæ and their allies. But it differs still more widely from Myriophyllum, with which the generic name given to it by my two friends associates it. This circumstance alone makes it important to change the name. As yet we have found no trace of an angiospermous phanerogam in the Carboniferous beds, and any name suggesting the probability of the existence of such is apt to be misleading. But apart from this suggestion of improbable affinities a second reason exists for changing the name. Unger has already adopted that of Myriophyllites for a genus of Tertiary plants, and the two names approach too nearly to make it desirable that both should be retained. One point appears to be indisputable:—The structure of the bark already referred to indicates either a marsh or an aquatic plant—an interesting fact, since it is the first example of such a plant from the palæozoic rocks that has hitherto come under my notice. We have numerous so-called aquatic roots described by various authors—and possibly they may be what they are affirmed to be, though we have no proof that such is the case; but I think that no such doubts can exist in reference to our new plant. Under these circumstances I propose for this plant the generic name of *Helophyton*, a name which involves no foregone conclusions as to its botanical affinities. Detailed figures of it will appear in the next (12th) part of my memoirs "On the Organisation of the Plants of the Coal-measures.

WM. C. WILLIAMSON

Victoria University, Manchester, December 3

The Pronunciation of Deaf-mutes who have been Taught to Articulate

MY attention has just been drawn to the remarkable statement of M. Hément (*C. R.*, xciii. p. 754), that deaf-mutes who have been taught to articulate speak with the accent of their native district; and to the equally remarkable letter of Mr. Wm. E. A. Axon, published in NATURE (vol. xxv. p. 101), in support of the same proposition.

I may say in this connection that I have during the past few years examined the pronunciation of at least 400 deaf mutes who have been taught to speak, without remarking any such tendency as that referred to above. It is true that in a few cases dialectic pronunciations are heard, but it always turns out upon investigation that such children could talk *before they became deaf*. The peculiarity is undoubtedly due to unconscious recollection of former speech, and cannot correctly be attributed to heredity.

M. Emile Blanchard (*C. R.*, xciii. p. 755) has directed attention to the harsh and disagreeable character of the utterance of many deaf-mutes who have been taught to articulate, but it has been found in America that this can be overcome by suitable instruction. I am happy to be able to say that I have heard from congenitally deaf children perfectly distinct and agreeable articulation.

The mouths of deaf children are in no way different from our own.[1] Deaf mutes do not naturally speak the language of their country for the same reason that we do not talk Chinese—*they have never heard the language*. They are dumb simply because they are deaf; and I see no reason to doubt that all deaf-mutes may be taught to use their vocal organs so as to speak at least *intelligibly*, if not as perfectly as those who hear.

In most, if not in all, of our American Institutions for the deaf and dumb, articulation is now taught as a special branch of education; and in many of our schools all instruction is given by word of mouth, as it has been found that large numbers of deaf children can be taught to understand spoken words by watching the movements of the speaker's mouth.

So successful has articulation-teaching proved in America and in Europe, that dumbness will soon be universally recognised as a mark of neglected education.

ALEXANDER GRAHAM BELL, Ph.D.
(Nat. Col. for Deaf Mutes, Washington)

London, December 5

The Function of the Ears, or the Perception of Direction

I SEE the above to-day in NATURE (vol. xxiv. p. 499) as a matter brought before the British Association at York, and as I can forward some results of experience, I beg to send the following:—In the cold season of 1868 I had to cut a straight line through dense forest half a mile long, between two given mounds, and availed myself of the known capability of Asamese in telling direction in such cases. Placing a man on one mound to shout now and then, a party of us went to the other mound and listened. On hearing the shouts I placed a long thin bamboo on the ground pointing from a peg in the direction of the shouts. While the men were clearing a space around I put another small peg in the ground, marking where the point of the bamboo fell. I took the bamboo up, and made the head man relay it himself, which he soon did, almost exactly where I had pegged it; thence we cut a true straight line, setting up peeled rods at every 50 yards, and eventually came out at 24 feet from the mound, in a distance of 45 chains. The jungle was dense, and we could never see more than about 12 or 14 yards in front. Lately having moved to a place where there are five tea-gardens in a semicircle around me, at distances of 5, 6, 4, 4½, and 4½ miles distant, I have heard several gongs in the early morning, and taking the bearing of the most audible, plotted it on the Government map, when it came out exactly among the houses in the "station" of the one at 4 miles; a repetition on other mornings confirms the direction. Distance does not seem any drawback, provided the sounds are loud enough; for in the great

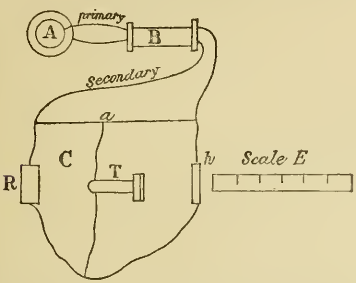
[1] I have examined the vocal organs of several hundred deaf-mutes, and while I have observed the most extraordinary differences in the size and shape of the palate, and in the appearance of the tongue, I have observed the same peculiarities in the mouths of hearing children, who talk perfectly well. The proportion of malformation of the vocal organs among deaf-mutes is certainly not greater than among hearing children. We occasionally meet with cases of cleft-palate, of double rows of teeth, and of tongue-tie, but such cases are altogether exceptional, and the vast majority of deaf-mutes have vocal organs as perfect as our own.

earthquake of January, 1869, the direction of the loud banging sounds like artillery was carefully marked against a peak in the Naga Hill range. Bearings by the prismatic compass subsequently sent to Calcutta to Dr. H. B. Medlicott, turned out to be within 3° of the true line to Cheduba and Ramree, the active volcanic centre, 550 miles off. I cannot exactly see how the difference of the *intensity* assists us in directing to the sound. I find I judge that best by facing it and remaining still, and verify the direction best by *looking* (with the eyes only) about 10° to right, and then 10° to left, which, if I do not move the head, soon enables me to fix by eye the direction pretty close.

Sibsagar, Asam, October 27 S. E. PEAL

An Audible Photometer

IN your issue of September 22 (vol. xxiv. p. 491, British Association Reports) Mr. Lant Carpenter mentions an idea of his about an "audible photometer." The same idea occurred to me some six months ago. As my plan seems to be much more simple than Mr. Carpenter's, dispensing with intermitting beams and rotating disks, perhaps you will allow me a little space to describe it. I require only one photophonic receiver, whereas Mr. Carpenter mentions "two precisely similar receivers," which is difficult, if not wholly impossible, to obtain. A is a small battery, B an induction-coil with the ordinary vibrating magnetic interrupter, and with a high-resistance secondary coil; C is the Wheatstone-bridge combination, S E a selenium cell, with its working surface



turned to the scale E; R is a high resistance of about the value of the selenium cell; a is a sliding contact, T a high resistance telephone. Now I place on the scale E a standard candle at a distance d from selenium cell, and move the sliding contact till no sound is emitted from the telephone. Then the wire connections are left wholly unaltered, and the candle is taken away. Now I place the light I wish to compare with the standard candle on the scale E, and move it along the scale till the telephone is again silent. Be the distance of the light from the selenium cell now D, then its luminous intensity is

$$\frac{D^2}{d^2} \text{ standard candles.}$$

As, on after-thought, I greatly doubted the fitness of selenium for photometric purposes (which doubts became the stronger the more I read about the subject), I did not pursue my idea, which could only result in an addition to the long list of practically useless photometers. The above may perhaps be used as a college experiment for demonstrating the law of the square of distances. J. W. GILTAY

Delft, November 21

Extraordinary Atmospheric Phenomenon

I INCLOSE a paragraph from the Glasgow *Evening Citizen* of this date relating to that peculiar form of lightning known as fire-balls. The explanation of the explosion in the funnel is, I think, erroneous, it having been caused by the explosion of the fire-ball, thus driving out the smoke by the fire-doors. The aurora was very bright here on Wednesday evening, showing Piazzi Smyth's line with a small direct vision spectroscope. Before the eye became sufficiently sensitive for measurement, clouds cut off the bright part. The aurora was a general bright northern glow without streamers, and was observed brightest a little after eight (p.m.). These notes may be of use to you in connection with those of other observers. J. B. HANNAY

Cove Castle, Loch Long, N.B., November 25

Extraordinary Phenomenon of the Storm

Those on board the Campbelton Steamer *Kinloch* (Capt. Kerr), which left Greenock on its usual run about half-past eleven o'clock on Tuesday morning after the storm that raged during the night, had a somewhat extraordinary experience while passing down the Firth. The vessel was enveloped in a dense shower of hail, and for some time it was awfully dark, and occasionally the vessel was lit up by vivid flashes of lightning. One of the flashes was very bright, and its shape was something like that of the arteries of the human body, with a central column all shattered and broken. About noon, while opposite the Cloch Lighthouse, and not far from the shore, the captain observed immediately over the ship what appeared to be a series of clear balls of lightning, each about a foot in length, and resembling a chain, except that they were disconnected. This phenomenon was quickly succeeded by an explosion in the funnel of the steamer, and several balls of fire upon the bridge running about, and then bounding off into the water. The first impression of the spectators was that something had exploded on board, but on inquiry it was found that this was not the case. The mate stated, however, that a ball of lightning had almost struck him where he stood. A fireman rushed upon deck to see what had happened, as the engine-room was filled with smoke, and a choking sensation was experienced below. The explanation appears to be that a portion of the lightning had passed down the funnel until its force was spent by the fire, and the sudden recovery of the draught of the funnel afterwards accounted for the loud report that was heard. The captain, in his long experience at sea, never encountered such a phenomenon before, and it may be taken as an indication of the extraordinary atmospheric forces which had been at work during the storm, and which seemed to centre in this locality.

Papin

IN the review of my "Life and Letters of Papin"[1] in NATURE, vol. xxiv. p. 378, the hope is expressed that I might succeed "to fill the *lacunæ* in the career of this remarkable man." The only important blank remaining now in our knowledge of Papin's life consists in our ignorance of the time of his death. We may rest assured that he died in London, and therefore this blank is not likely to be filled but by a person who is familiar with the city and its inhabitants of the present and of the beginning of last century. Papin died about 1712. During 1709 he lived at "Madam Postal chez M. Charron, apothécaire dans Compton Street, proche St. Anne." As it is not probable that he changed his lodgings before his death a search in the registers of the district to which Compton Street belonged (if they are in existence) would lead to results equally important for the history of science and for that of technology. Maybe a reader of this note who enjoys such opportunities will render me his assistance in this thankful task.

I avail myself of this opportunity of correcting a few slight mistakes which have found their way into the otherwise excellent *résumé*. Not Papin but Leibnitz is the author of the letter of February 4, 1707, which contained the first idea of the "hot-air engine." Leibnitz is therefore the inventor of the same. That boat, in which Papin left Cassel in 1707 to sail to Bremen, was not a "steam propeller boat," but a small ship with paddle-wheels to be worked by the sailors. It was not Papin's intention to proceed to England in that boat. He left Cassel with proofs of the favour and goodwill of the Landgraf, which remained unchanged to the end. Lastly, before Papin no steam-engine existed; he is the real inventor of the same, for he in 1690 first announced the idea, and tested it by experiments of utilising the pressure of steam as motive power for engines. This, his first engine, had a piston inside a cylinder. Such an arrangement was not at all new at that time; other machines had the same, as, for instance, the gunpowder engine of Huyghens, which suggested the invention of Papin. Leibnitz corresponded with the inventor about this engine much later, and made valuable propositions, but the correspondence of these

[1] Leibnizen's und Huygens' Briefwechsel mit Papin, nebst der Biographie Papin's und einigen zugehörigen Briefen und Artenstücken. Bearbeitet und auf Kosten der Königlichen Preussischen Akademie der Wissenschaften herausgegeben von Dr. Ernst Gerland. Berlin, 1881. Verlag der Königlichen Akademie der Wissenschaften.

two *savants* did not commence before 1692. It is therefore out of the question to credit Leibnitz with the invention of the steam-engine or even with the application of the piston principle in the steam-engine.

E. GERLAND

Cassel

A Question for Naturalists

MR. PAUL DU CHAILLU, in his "Land of the Midnight Sun," tells us that "the time of dropping the horns in a herd (of reindeer) varies from March to May." This may be true as regards the young males up to two or three years of age, and of the does, but it is questionable as regards the full-grown males. If my memory serves me correctly, the full-grown bucks brought to this country with some Lapps a year or two ago, and exhibited at the Aquarium, shed their horns in December or January. The experience of a gentleman—one of the highest authorities in such matters—who holds a most important position at the Zoological Gardens, supports my view. Can the Lapps have two kinds of reindeer which shed their horns at different seasons? I know that the full-grown male reindeer of the barren grounds of America drop their horns in the latter part of November and in December (which does away with the erroneous idea that this animal used the broad brow antler as a shovel for clearing away the snow so as to reach his food); the young buck of two or three years retains his horns until spring, and the full-grown female does not shed her horns until May or June, usually after having dropped her calf.

J. RAE

4, Addison Gardens, November 19

Earthquake Vibrations

IN a note in your issue of August 25 on my account of the earthquake of March 8, 1881, felt in Japan, it is said "that from the phenomena of the shock and from experiments on artificial earthquake waves produced by letting an iron ball weighing about one ton fall from a height of about thirty-five feet, Mr. Milne agrees that the waves that are felt are transverse to the line of propagation of the shock." Lest it should be thought that all the earthquakes which shake the residents in Japan are composed of transverse vibrations, allow me to make the following brief statements:—

1. In the earthquake of March 8 my seismographs chiefly indicated east and west motions, whilst time observations made in Yokohama, as compared with similar observations made in Tokio, showed that the earthquake must have travelled up from the south. This particular earthquake, as recorded in Tokio, might therefore be called a transverse or diagonic shock.

2. In other shocks normal or direct vibrations are the most prominent. These shocks might be called euthutropic.

3. Others again are compounded of direct and transverse motions, and might therefore be called diastrophic. Thus my records of the shock of July 5, 1881, very clearly showed a variation in the direction of the motion of the ground. At the commencement of the shock the motion was N. 112° E.; $1\frac{1}{2}$ second after this the direction was N. 50° E.; $\frac{3}{4}$ second more it was N. 145° E.; and after a similar interval N. 62° E. These and other changes were very clearly indicated in the diagram written by a double-bracket seismograph.

4. Anaseismic shocks, or those where vertical motion is prominent, which vertical motion may sometimes be a component of the transverse motion, appear to be rare.

5. In the artificial earthquakes produced by the blow of a falling ball the seismographs very clearly wrote both normal and transverse vibrations. When bracket-ring seismographs were used, these two sets of vibrations could be separated and their respective velocities, &c., measured. When a single component seismograph was used, the resultant motion due to the composition of these two sets of vibrations was recorded. The results of these experiments, which experiments were made in conjunction with my colleague Mr. T. Gray, will very shortly be published.

JOHN MILNE

Imperial College of Engineering, Tokio, Japan, October 13

The Geological Survey of Italy

MY friend Mr. W. Topley, in his interesting account of the Italian Geological Survey (NATURE, vol. xxv. p. 86), is quite right when he states that the geological surveyors seem now to have definitely fixed the position of the Carrara marbles in the Trias. If, however, he means to imply that the geological world at large will accept this decision, I fear he is mistaken. The patient toil, spread over many years, and carried on by M. Coquand with more than due regard to Buffon's advice to geologists, "*Il faut voir beaucoup et revoir souvent,*" gives him such authority when speaking on the structure of the Apuan Alps and the Campigliese, that nothing but the most absolute proof that he is wrong in regarding the metamorphic marbles of Carrara, as well as those of the Pyrenees (St. Béat, &c.), as being of Carboniferous age, will prevent foreign students of Italian geology from accepting his views on the matter. I have read, I think, all that has been written in Italy by De Stefani and others on the point in question since the publication in full of M. Coquand's mature conclusions in the *Bulletin de la Société géologique de France*, in 1874, and I still regard his position as entirely unassailed. In 1876 I published in the *Geological Magazine* a short *résumé* of M. Coquand's results, to which I would refer any who are interested in the subject.

G. A. LEBOUR

OUR ASTRONOMICAL COLUMN

THE PROVINCIAL OBSERVATORIES OF FRANCE.—We have before us the "Rapport adressé par le comité consultatif des observatoires astronomique de province, à M. le Ministre de l'Instruction Publique," signed by M. Lœwy, as reporter. In the year 1880 a great impulse appears to have been given to what is termed the reform of French astronomy, a considerable grant having been obtained by the Minister of Public Instruction, which allowed of most material improvement in the equipment of the several observatories of the provinces. Stress is laid upon the reorganisation of the observatory at Algiers, which is placed under the direction of M. Trepied, and the Committee urge that special attention should be given to the proper equipment of an establishment which has the advantage of so exceptional a climate. The observatory at Marseilles is still under the direction of M. Stephan, who has done such excellent work for many years past, and MM. Borrelly and Coggia were the assistant-astronomers in 1880: a revision of the star-catalogue formed by Rümker at Hamburg is in progress at Marseilles. At Toulouse, M. Baillaud is the director; he proposes to devote special attention to the observation of the variable stars. In 1880 a regular course of observations of the solar spots was maintained, and it is mentioned that during the nights August 9–13 three observers counted upwards of 1200 meteors of the Perseus shower. At the observatory of Bordeaux, M. Rayet is director; an equatorially-mounted refractor of 14-inches aperture has been ordered from Merz of Munich, and a second of 8-inches aperture is also to be provided. Two observers were engaged in 1880 upon a revision of the charts of Chacornac. The observatory at Lyons includes four stations, three of them devoted to meteorology: the astronomical station is at Saint-Genis-Laval, where M. André is director, and the principal instrument in process of construction in 1880 was a meridian-circle of 6-inches aperture by Eichens. The State-subvention to these observatories is 81,000 francs, and further funds are provided by the cities of Bordeaux, Marseilles, and Toulouse for their respective establishments.

The Report is a very encouraging one in its bearing on the advancement of practical astronomy in France.

DENNING'S COMET.—Dr. Hartwig has corrected his first ellipse with the aid of an observation by Prof. Winnecke on November 19, in addition to earlier ones at Marseilles and Strasburg, and now finds the period of revolution 8·8334 years, or 3226·4 days. With the corrected orbit the nearest approach to the orbit of Jupiter occurs in 222° 35′, heliocentric longitude, where the distance is 0·154, the comet is at this point about 593 days before perihelion passage. It approaches nearest to the orbit of Venus 5·6 days after perihelion passage in longitude 30° 45′, where the distance is only 0·0226, while in longitude 82° 35′, about 36·7 days after perihelion passage the comet's distance from the earth's orbit is at a minimum of 0·0346.

A NEW COMET.—A Dunecht circular issued on November 22 contained elements of a comet from observations made by Mr. Wendell at the observatory of Harvard College, U.S., on November 17, 19, and 20. Prof. Winnecke has observed this comet as follows:—

	Strasburg, M.T.				R A.				Decl. N.		
	h.	m.	s.		h.	m.	s.		°	′	″
Nov. 25	9	54	33	...	0	30	39·46	...	63	52	2
26	6	3	31	...	0	25	25·44	...	62	35	21

These places differ considerably from the ephemeris telegraphed to Dunecht.

THE PRESSURE ERRORS OF THE "CHALLENGER" THERMOMETERS[1]

II.

XI. *Accurate Measurement of Great Pressures.*

IT will be obvious from what has been said, especially as regards the old apparatus which was carried about in the *Challenger*, that one of the most essential requisites of the whole investigation was the accurate measurement of pressure. All the ordinary forms of pressure-gauge were found to be untrustworthy. It was necessary that in all cases the pressure should be measured with certainty to about 1 per cent. No attempt was made to secure any greater degree of accuracy, as the indications of the thermometers themselves could not in any case be trusted to less than 0°·1 Fahr.

The basis on which, after a great many trials, I finally founded my determination of pressures, was Amagat's[2] remarkable measurements of the volume of air and other gases at high pressures. Amagat's data were obtained in the most direct and satisfactory manner, inasmuch as he measured his pressures by means of an actual column of mercury extending sometimes to 300 metres, and more. All other means of measuring pressure are as it were valueless in comparison with this. We know by these experiments the compressibility of nitrogen, and of air, up to pressures of at least two and a half tons weight per square inch, with almost all desirable accuracy.

All that was necessary therefore in order to determine the pressures in the operating cylinder, and thus to calibrate the gauges employed, was to compress once for all a quantity of air, measure the volume to which it was compressed and the corresponding indications of the gauges, and then by the help of Amagat's tables compute the pressure actually attained. The apparatus I employed for this purpose is figured in section in the diagram below.

FIG. 4.—Air-gauge giving pressure (after Amagat).

This apparatus, filled with dry air, was allowed to come exactly to the temperature of the water inside the compression apparatus; then, the open lower end of it being dipped into a large vessel of mercury, it was let down full of air into the compression cylinder and pressure was applied. The effect was of course to compress the air, force up the mercury until it gradually filled the vessel and forced the air entirely into the smaller bulb. After a few trials we found roughly what amount of pressure was necessary in order just to commence the forcing of mercury into the small bulb. The mercury forced in was weighed; then the capacity of the small bulb was determined by weighing its contents in mercury. The difference of these weights is the weight of mercury, which would occupy the same volume as did the air when compressed. Finally, the original volume of the air was found by weighing the whole apparatus, first empty then filled with water; and, most important in view of Amagat's results, the barometer and thermometer were carefully observed at the instant when the apparatus had its lower end placed in the vessel of mercury. Mr. Kemp, who made these instruments for me, suggested and carried out the great improvement of inserting a small triangular pyramid of glass into the choked part of the bore (as shown in the small sketch). The effect is to break the mercury (which must be very clean) into exceedingly small drops. In this way the actual compression of the air was determined with a limit of error, represented at the utmost by the ratio of the volume of one of the small drops of mercury formed at the obstruction to the whole capacity of the small bulb. By working simultaneously with three instruments of this kind, even this very small error could be in great part eliminated:—and, practically, the compressions were measured far more accurately than was at all necessary for the purpose in hand. For greater accuracy a larger apparatus would be required. This, however, was quite unnecessary. And the requisite limit of accuracy in the experiment rendered it unnecessary to correct for the alteration of volume of the smaller bulb consequent on the pressure to which it was subjected.

In my later experiments a long carefully-gauged tube of 1·5 mm. in bore was substituted for the small bulb. This tube was coated internally with an excessively thin film of metallic silver thrown down by sugar of milk. The process was arrested the moment the film became visible by reflection. This film is at once dissolved by the mercury up to the point which it reaches at the greatest pressure, and leaves a perfectly sharp and nearly opaque edge from which to measure. This device has proved so very successful that I have now substituted it for the indices in all the pressure gauges (shortly to be described) which are employed for very accurate measures. And I am at present engaged in measuring, by comparison of a glass gauge and an air-gauge both filled in this manner, the compression of various gases at pressures up to fourfold those applied by Amagat.

XII. *Internal Pressure Gauges.*—The next step was to find some plan of construction for an instrument which, having its scale determined once for all by comparison with the air-gauge, should ever afterwards serve instead of it, thus affording a ready measure of pressure. Liquids are obviously better fitted for this purpose than solids, if only on account of their absolute homogeneity and their greater compressibility. But, unfortunately, *two* liquids must be employed, since a record must be kept:—the apparatus being surrounded on all sides by nine inches of iron:—and all my trials with two liquids were more or less unsatisfactory. The very fact that I was dealing with thermometers whose bulbs were protected from pressure, at once suggested an unprotected thermometer as something perfectly well suited to the purpose so long as the glass might be trusted to follow Hooke's law. [I have since found that the invention of such an instrument, to be used as an *élateromètre*, is due to Parrot.[1] His investigation of the effects of pressure is wholly incorrect, as it takes no account of distortion; but the device, and the recognition of the fact that its indications are proportional to the pressure, are wholly his.]

These instruments, which, like the thermometers, are fitted with a needle-index with hairs attached, have only one defect, which is that they act like thermometers as well as pressure-gauges. That defect I managed to remove almost completely by the simple device of inclosing in the bulb a closed glass tube which *all but* fills it. The liquid then occupies only a small space between the interior tube of glass and the exterior tube forming the bulb, and is as ready as ever to give indications of pressure, while it is not in sufficient volume to be more than slightly disturbed even by a serious change of temperature.

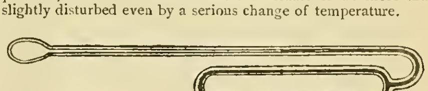


FIG. 5.—Internal gauge, plugged.

It is quite easy, by comparing two instruments of this kind in which the ratios of the internal to the external radius of the cylindrical bulb are different, to find by trial through what range its indications are strictly proportional to the pressure. Thus all the requisites of a perfect gauge, so far as the experiments required, were met by this simple apparatus. That I have obtained a sufficient accuracy in the graduation of these instruments is proved by the close agreement between my results for the volumes of air at different pressures as measured by means of them, with the volumes corresponding to these pressures in Amagat's table. If Boyle's law had been even approximately true for these high pressures, this mode of verification would have been fallacious. It would, however, be easy to make an independent verification, by sinking some of these instruments, each thoroughly imbedded in a mass of lard (as a protection

[1] By Prof. Tait. Abridged by the Author from a forthcoming volume of the Reports of the Voyage of H.M.S. *Challenger*, by permission of the Lords Commissioners of H.M. Treasury. Continued from p. 93.

[2] "Mémoire sur la Compressibilité des Gaz à des pressions élevées," par M. E.-H. Amagat (*Ann. de Chimie et de Physique*, 1880).

[1] "Expériences de forte compression sur divers corps, par M. Parrot" (*Mémoires de l'Académie Impériale des Sciences de St Petersbourg*, 6me. série, tome ii., 1833). The pages are headed "Parrot et Lenz," and it was by mere accident (seeking in the Royal Society's "Catalogue of Scientific Memoirs" for a reference to Lenz's thermo-electric writings) that I lit on the paper. I was much surprised at some of the statements it contains, till I found at the very end a footnote by Lenz, in which he disclaims all responsibility for the writing of the paper, and for the conclusions drawn in it.

from shocks) to a measured depth in the sea. This idea is worthy of consideration, especially if the gauge be made to register by means of a silvered tube. The only probable cause of error in such a case would be the breaking of the mercury column by a jerk, and to this all other forms are at least equally liable.

XIII. *External Pressure Gauge.*—But it was necessary not merely to measure accurately the pressure applied, but also, for the sake of the thermometers, to provide that the pressure should not be carried too far; and for that purpose it was indispensable to have an exterior indicator of pressure. This was furnished by a thin cylindrical steel tube inclosed in a cavity bored in a large block of iron, the interior of the steel tube being full of mercury and the narrow space between it and the large iron block also full of mercury. This exterior space was connected with the pressure apparatus. The pressure then throughout the whole of the space exterior to the steel cylinder was the pressure in the pump. The steel cylinder was therefore compressed from the outside. In the neck of the steel cylinder, which was screwed into the surface of the block, there was luted a vertical glass tube. It was exposed to no pressure, but the mercury in it rose, by the compression of the steel cylinder, and the height to which it rose could be easily measured. Comparative experiments were made several times by putting one of the glass gauges, whose scale had been carefully ascertained, inside the apparatus, while this newly-described gauge was also connected with it. In this way the external gauge was accurately calibrated. But, lest an accident should happen to one of the gauges, or to its index (as sometimes was the case) no experiment was made without the presence of at least three gauges. The way in which these worked together during the whole course of the experiments is the best possible proof of their value. This form of gauge, also, is greatly improved by inserting a glass tube closed at both ends into the bulb; for the temperature changes produced by pressure in mercury are greater than those in water at ordinary temperatures.

XIV. *Results of the Experiments. The True Correction for Pressure is very small.*—As soon as I applied pressure to the *Challenger* thermometers I found I reproduced pretty nearly the results obtained by Capt. Davis. I had already seen one proof that at least a large part of the result was in all probability not due directly to pressure. The experiment with the long thermometer tube showed that my theoretical calculations had been correct. The question thus became:—Is this a pressure effect of any kind; and, if so, how does it originate? and if it is not a direct pressure effect, to what is it due? There are many ways of answering such questions. One answer was furnished by one of the thermometers (A 3), whose degrees (especially on the maximum side) are very short. The whole effect (in degrees) on this thermometer was not very markedly greater for a given pressure than on the others, as it would certainly have been had the effect been entirely due to pressure directly. Another is, if it be not a direct pressure effect it must be a heating effect. With Sir Wyville Thomson's permission I got from Mr. Casella, the maker of the *Challenger* thermometers, a couple of others of exactly the same form and dimensions, but with the bulbs plugged after the manner of the gauges already described, so as to diminish their susceptibility to changes of temperature. When I put one of these into the pressure apparatus along with one of the *Challenger* thermometers, I found the effects on the new form very much smaller than on the old. Thus it was at once proved that the effect could not be due to wry neckedness produced by the fitting on of the protecting bulb; which would have been an effect due to pressure directly; but that it must be an effect due to heat. That is to say, it was now completely established that the large results obtained by Capt. Davis are due in the main to causes which can produce no effect when the thermometers are let down gradually into the deep sea; they are due to causes connected with the thermometers, and perhaps also with the pump, but solely under the circumstances of a laboratory experiment.

XV. *Sources of the large Effect obtained in the Press.*—Now comes the question (no longer important to the *Challenger* work, but of great scientific interest), What are these various sources, and how much of the effect is due to each? First of all we have seen that the water in the press is heated when pressure is applied. Using Sir William Thomson's formula I found the amount of that heating should be about 0°·05 F. at 43° F., 0°·16 at 50°, and only 0°·3 at 59°, for one ton of pressure. [These numbers are rather too small. We do not yet know to what extent the temperature of the maximum density point of water is lowered by pressure.] These cannot be expected to be fully shown under the circumstances of the experiments, and even if they were fully shown the greatest of them represents only about one-half of the whole of Capt. Davis' result; there must therefore be some other cause. [Prof. Tait then gives details of the various experiments by which he traced the sources of the large effect obtained.]

Thus it appears that there are no less than five different causes which contribute each its share to Capt. Davis' result. Of these, one is independent of the others, and would produce its full effect even if they were not present. The other four give effects which are not cumulative, and it would be very troublesome to try to assign to each its exact share of the result when two or more act together. Fortunately, it will be seen that we do not require to attempt to solve this problem.

(1.) First is the direct effect of the external pressure upon the exposed part of the thermometer tubes. This, in general, will be found very small, except in tubes where there are large aneurisms. The whole effect of 3 tons pressure on a *Challenger* thermometer without aneurisms, at temperatures near freezing point, so far as the minimum index is concerned, would be only about 3 one-thousandths of 30 degrees or so, that is 90 thousandths or at most 0·1 of a degree for 3 tons pressure. That is an amount which, in consequence of the necessary errors of reading the thermometers, may be entirely neglected, and, unless there are large aneurisms, there will be little need for pressure corrections even in six miles of sea.

The other parts of the observed effect were

(2.) Heating of water. This I observed to follow very nearly, according to Thomson's formula, the original temperature of the water. By comparing the pressure effects on the same thermometers during summer, and during winter (for which latter the late continued frost was of particular service, and enabled me to work for many days at the temperature of the maximum density of water), I found the results to vary in accordance with calculation.

(3.) Heat due to friction during pumping. This from its very nature was unavoidable unless we could have got an apparatus into which (by enormous pressure) the plug could have been forced directly. This could not, however, have been done in my laboratory, even if the apparatus had been adapted to such a form of experiment. But it was very easy to calculate the extreme possible amount of this effect.

(4.) The peculiar heating effect due to the vulcanite mounting. I verified this effect of vulcanite by taking a thermometer which had no vulcanite about it and measuring the effect produced upon it by a definite pressure, and then putting loosely round the bulb (in a test-tube, which had itself been previously experimented on) a small quantity of vulcanite in thin plates. I found that so little as 8 grammes of vulcanite round the protecting bulb raised the effect produced by a pressure of 3·2 tons weight from 0°·5 F. to 1°·1 F. The vulcanite was in thin strips about a millimetre and a half in thickness. The effect of the vulcanite on the *Challenger* thermometers (in the hydrostatic press) must, from the mode of their construction and mounting, in all cases be considerably greater than this.

Under these circumstances, we might without farther inquiry fairly attribute the whole outstanding effects to the massive vulcanite slabs on which these thermometers are framed. But there still remains

(5.) The most difficult question of all, the temperature effect produced by pressure upon the protecting bulb, which is under different circumstances altogether from the vulcanite; for the vulcanite is simply compressed, while the glass sheath is under pressure on one side and not on another, and is therefore subject to shear as well. In its interior the glass is extended in a radial and compressed in a tangential direction. Nobody has yet made any approximation to an answer to the question what effect in the way of heating or cooling will be produced by deformation which consists partly of compression and partly of change of form. We know that in indiarubber a cooling effect is produced by traction, and it may happen that a similar change of form in glass also produces a reduction of temperature. This is a question, however, which is not capable of answer by the help of my present apparatus;—though it will probably be answered by experiment before theory is able to touch it. The results of my experiments on the thermometers with plugged bulbs show that, on the whole, a heating effect results from the combined compression and shear in a bulb exposed to external pressure only. This has been verified by cutting down a thermometer, an exact counterpart of the *Challenger* thermometers

but without aneurisms, taking out the greater part of the mercury and inserting a second (now a maximum) index in the minimum side of the tube. When this instrument was stripped of its vulcanite, the effect of pressure at 40° Fahr. was considerably greater than that due to compression of the tube.

But it does not require to be taken into account so far as the *Challenger* thermometers are concerned.

XVI. *Final Conclusion from the Investigation.*—The final conclusion is that only one of these five causes, which are active in the laboratory experiment, can affect the *Challenger* thermometers when let down into the sea, namely, pressure. There is there no heating of water by compression; there is no heating by pumping; there is no heating of vulcanite, because the thermometers are let down so quickly in comparison with the rate of increase of pressure that each little rise of temperature is at once done away with as the thermometer passes through a few additional yards of water; and the effect on the protecting glass also, for the same reason, which is a heating effect on the whole, is all but done away with step by step as it is produced. All these four causes, therefore, which made Capt. Davis' correction so much too large, are valid only for experiments in a laboratory press, and not for experiments in the deep sea. Therefore, as a final conclusion, I assert that, if the *Challenger* thermometers had had no aneurisms, the amount of correction to be applied to the minimum index would have been somewhat less than 0°·05 F. for every ton of pressure, *i.e.* for every mile of depth. All the thermometers which have large aneurisms have had special calculations made for them, but in no case does the correction to be applied to the minimum index exceed 0°·14 or about one-seventh of a degree per mile of depth.

[From] the *Appendices* to Prof. Tait's Report, which contain numerous formulæ with detailed descriptions of apparatus and modes of experimenting, we make the few following extracts.]

The diminution per unit volume of the interior of a cylinder with closed ends, of internal radius a_0, and external radius a_1, when exposed to an external pressure Π, is

$$\Pi\frac{a_1^2}{a_1^2 - a_0^2}\left(\frac{1}{n}+\frac{1}{k}\right).$$

Here n is the rigidity, and $\frac{1}{k}$ the compressibility, of the walls of the cylinder.

When Π is a ton-weight per square inch, the value of the quantity

$$\Pi\left(\frac{1}{n}+\frac{1}{k}\right),$$

is, according to the best determinations, somewhere about $\frac{1}{1000}$ for ordinary specimens of flint glass, and about $\frac{1}{1000}$ for steel. This expression is very simple, and enables us at once to calculate the requisite length of bulb, when its internal and external radii are known, which shall have any assigned sensitiveness when fitted with a fine tube of a given bore. To obtain great sensitiveness, increasing the diameter of the bulb is preferable to diminishing its thickness, as we thus preserve its strength; and we have seen how to avoid the complication of temperature corrections.

As a verification of this formula, in addition to the simple one described in the text above, I had an apparatus constructed of ordinary lead glass of the following dimensions:—Length of cylindrical bulb, 745 mm. Ratio $a_0 : a_1 = 8·7 : 21·9$. The weight of mercury filling 424 mm. of this bulb was 167 grm. To the bulb was attached a smaller tube of which the mercury filling 68 mm. weighed 1·43 grm.

Hence we have

$$\frac{a_1^2}{a_1^2 - a_0^2} = 1·187.$$

Also the content of the whole bulb in mercury is $\frac{745}{424}167$ grm. = 293·4 grm. Hence a pressure of one ton-weight should force into the narrow tube $\left(\frac{1·187}{1000}293·4 =\right)$ 0·348 grm. of mercury. This ought to displace the index through $\left(\frac{0·348}{1·43}68 =\right)$ 16mm.·55.

Comparing this with the result of experiment, we had the following remarkably satisfactory numbers:—

Tons.		Calculated.		Observed.
0·9	...	14·9	...	14·6
1·4	...	23·1	...	21·2
3·1	...	51·3	...	48·9

There was no glass tube in the interior of the bulb, so that the slight discrepancies between the ratios of calculated to observed effects are mainly due to effects of temperature.

In the *Proc.* R.S., June, 1857, Sir William Thomson gives for the rise of temperature of a fluid, the pressure on which is suddenly raised from p to $p + \omega$, the general expression

$$\frac{te}{JK}\omega.$$

Here t is the absolute temperature of the fluid; e its coefficient of expansion, and K its average capacity for heat, under constant pressure, between p and $p+\omega$. J is Joule's equivalent.

The value of e, as given by Kopp's experiments, is nearly

$$\frac{t-278}{72,000},$$

for temperatures within 20° C. of the maximum density point. The mean of the experimental determinations of Matthiessen, Pierre, and Hagen, makes it about 5 or 6 per cent. greater.

For the Centigrade scale the value of J is 1390 foot-lbs. An atmosphere of pressure is nearly 2117 lbs. weight per square foot; and K is about 63·45 (the number of pounds of water in a cubic foot).

Hence it follows that, for one additional atmosphere of pressure, the temperature of water is raised (in degrees Centigrade) by about

$$\frac{t(t-278)}{2,850,000}.$$

Now 56° F. is 13°·3 C., for which $t = 287·3$, and the rise of temperature produced by a ton-weight per square inch is

0°·14 C. or 0°·25 F.

This is the statement in the text.

From the above formula we find the heating effect of one ton pressure on water at 50° F. to be nearly

0°·16 F.;

and for each degree above or below 50° F. this number must be increased or diminished by about one-tenth of its amount.

This expression is very easy to recollect, and it gives the results with ample accuracy throughout the whole range of temperatures (40°–60° F.) within which my experiments were conducted.

It is to be observed that Thomson's formula is strictly true for small pressures only. No account has been taken of a possible lowering of the temperature of maximum density, or of a change of expansibility, under pressure. Nor is it known how a considerable increase of pressure affects the thermal capacity.

On the first occasion on which one of the thermometers gave way, we were much surprised at the loudness and musical quality of the sound produced. The whole mass of iron and steel vibrated like a bell in consequence of the (comparatively slight) sudden relaxation of pressure. On another occasion, just as a pressure of three and a half tons had been reached, the whole apparatus gave a strong, protracted musical sound, which continued until the screw-tap was opened. This was probably due to a species of hydraulic-ram behaviour on the part of one of the valves of the pump. These are little conical pieces of steel, with the points much elongated, which are ground accurately into conical beds, and fall back into their places by gravity. It was not observed that this powerful vibration had in the least degree altered the position of the indices in the thermometers or gauges which were in the pressure chamber. Their indications agreed perfectly with those of the preceding and succeeding day.

I made a number of experiments with the view of determining the amount of distortion at which glass gives way, with the view of finding the limit of strength of a glass tube, and also the ratio of external to internal diameter to secure it against any assigned lower pressure. I allude to them now in consequence of a curious fact observed, which gives the explanation of a singular occurrence noticed on board the *Challenger*. The walls of the tubes, when they gave way, were crushed into fine powder, which gave a milky appearance to the water in the compression apparatus. But the fragments of the ends were larger, and gave much annoyance by preventing the valves of the apparatus from closing. To remedy this inconvenience, I inclosed the glass tube in a tube of stout brass, closed at the bottom only, but was surprised to find that it was crushed almost flat on the first trial. This was evidently due to the fact that water is compressible, and therefore the relaxation of pressure (produced by the break-

ing of the glass tube) takes time to travel from the inside to the outside of the brass tube; so that for about 1-100coth of a second that tube was exposed to a pressure of four or five tons weight per square inch on its outer surface, and no pressure on the inner. The impulsive pressure on the bottom of the tube projected it upwards, so that it stuck in the tallow which fills the hollow of the steel-plug. Even a piece of gun-barrel, which I substituted for the brass tube, was cracked, and an iron disk, tightly screwed into the bottom of it to close it, was blown in. I have since used a portion of a thicker gun barrel, and have had the end welded in. But I feel sure that an impulsive pressure of ten or twelve tons weight would seriously damage even this. These remarks seem to be of some interest on several grounds, for they not only explain the crushing of the open copper cases of those of the *Challenger* thermometers which gave way at the bottom of the sea, but they also give a hint explanatory of the very remarkable effects of dynamite and other explosives when fired in the open air.

To show how possible is a serious mistake in the measurement of pressure, I append a comparison of the indications of the very elaborate gauge attached to the old *Challenger* apparatus with those of my steel external gauge already described. The scale of the *Challenger* gauge is divided to cwts. on the square inch. My gauge gives very nearly 20 mm. per ton; so that, for a rough comparison, we may take 1 mm. as equivalent to 1 cwt. The two instruments were simultaneously attached to the pump, and the pressure was therefore the same in both at each reading. There can be no doubt whatever, from repeated comparisons with glass gauges of all sizes and shapes, that my gauge follows Hooke's law with great accuracy. The only possibility of serious error is in the actual value of the unit. This important determination has, however, been very carefully repeated by the aid of Amagat's numbers and the indications of the silvered gauge already described; and the result is as above stated.

Steel Gauge. Millimetres.	*Challenger* Gauge. Cwts. per sq. in.	Ratio.
0	0	...
5	0	0·0
9	1·2	0·13
15	8·7	0·58
20	13·9	0·69
30	23·6	0·78
40	35·0	0·87
50	47·0	0·94
60	58·7	0·98
70	71·7	1·02

The comparison was repeated several times with almost exactly the same results.

It is quite clear that the *Challenger* gauge does not follow Hooke's law. It lags behind the steel gauge at first (does not give any indication, in fact, till the pressure is nearly 50 atmospheres), then gradually gains on it; and, at pressures greater than 3½ tons, appears to leave it rapidly behind. The instrument is, however, graduated up to 4 tons only. My very first experiments with this *Challenger* instrument, in which I used a simple form of manometer, showed that it was not trustworthy, and led me to make various trials for the purpose of getting a proper mode of measuring high pressures.

Finally, it may be interesting to mention that a fairly approximate determination of the compressibility of water was made by counting the number of strokes of the pump required to produce a measured pressure in the interior of the large apparatus.

[Then follows a table of the experimental data for each of a large series of the *Challenger* thermometers. These are of no general interest. Their importance is confined to the reduction of the actual observations made on board the *Challenger*].

THE GRASS BARRIERS OF THE NILE

THIS interesting phenomenon, which so largely contributes to produce changes in the bed of the Nile and to accumulate river formations of great geological importance, has been recently investigated by M. Ernest Marno, who has just published an elaborate paper on the subject, in the last number of *Petermann's Mittheilungen*. It is accompanied by a map, on the scale of 1 to 500,000, of the Bahr-el-Gebel and of the Bahr-el-Abiad, from Geseir Abbas to Sohat, and of the Bahr-el-Serat from its mouth to 7° 30′ N. lat. After having made its way among the hilly region, through several great lakes, formerly forming a series of terraces and connected together by short rivers, the Nile, or the Bahr-el-Gebel—the River of the Mountains—enters an extensive flat land, which it crosses over six degrees of latitude to the next rocky barrier, which it cuts through at Khartum. Over this stretch it runs with numerous windings, first north to its confluence with the Bahr-el-Ghazal, and then to the east, under the name of Bahr-el-Abiad, and, although the direct distance between its issue from the hilly tract to Khartum is only 600 miles, the total length of the river with its windings is no less than 1100 miles. The whole of this region is a wide marsh, and the river has no proper banks, its water being mixed with that of marshes which cover the whole of this tract. It is even a rare occurrence to see dry banks, as the country is more like an extensive marsh, through the midst of which a somewhat deeper channel has been dug by the current of the river. Numerous smaller rivers connected together and with the main channel and its numerous ramifications circulate amidst these marshes, and during the rainy season the *maije*, or lateral ponds and lakes, increase yet more, covering wide tracts of land, whilst during the dry season some stretches of banks re-appear, and the lakes which were navigated by steamers some months before become simple marshes. Vegetation plays an important part in the modifications which are going on in this region. The country is covered with rich grasses, mostly consisting of such species (*Saccharum spontaneum*, *S. irschæmum*, *Vossia*) as grow perfectly well even in water; this grass can be lifted with its roots by water, and grow floating on the surface, so as to render it most difficult to draw a line of demarcation between land and water. Thick and high papyrus palms grow sometimes on the very banks of the main channels of circulation of the water, and strengthen these by their complicated roots, but they do not cover all the banks, and the outlines of the river are mostly indefinite. Some few tree-like *Herminiera elaphrosylon* grow as isolated individuals on the banks of the rivers, and of the *maije*, whilst the smaller marshy and aquatic flora (*Pistiæ*, *Nymphеæ*, *Vallisneriæ*) nearly disappears in comparison with the rich vegetation of the above-named species. The fauna of this region closely depends upon the season. Mammals and birds leave it during the rainy period and wander to the hilly tracts, but during the dry season the banks of the *maije* and of the rivers are peopled with elephants, buffaloes, giraffes, antelopes, and by many kinds of birds. Besides this region has also its special forms, namely the *Balæniceps Rex*, the *Protopterus æthiopicus*, and the ganoid fish, *Polypterus*, all being remains from earlier geological periods. The people who inhabit this region, the Dinka, the Shilluk, and the Nuehr, all belong to a very low level of civilisation, living mostly on their herds of cattle; they change their abodes in accordance with the season, but they cannot be considered as true nomades, as the land occupied by each tribe is strictly limited by other tribes, and every encroachment on another's land is punished by war.

It is obvious that in this region the fall of the rivers is very small and that the regular outflow of water may be checked by winds and other occasional circumstances; whilst the great quantities of water poured down into the basin during the rainy season cannot find an easy way through the flat channels; extensive inundations occur therefore every year, and when the rains are especially heavy, great masses of floating grass are brought from the *maije* into the main river, and accumulate in its windings. New floating islands of grass are brought by and by to these barriers, being pressed upon or beneath them, and soon the whole of the river throughout its width and depth is obstructed by these barriers, which the inhabitants call *setts*. The grass does not decay in

the *setts*, it continues to grow on their surface, and if the vegetation, which rises two or three metres above the water, is burnt, it soon reappears again, reaching a height of one metre and more after eight or ten days. The thread-like roots of the grass form a kind of rough felt, in which palms are sometimes inclosed, whilst masses of ooze fill up the interstices between the roots, and form thus true dams across the river. When the barrier has not yet reached a great size, it might be occasionally destroyed by the pressure of water accumulated above it; but, as several barriers are formed at the same time at various places, the upper one being destroyed, its *débris* is brought to the lower one, and accumulates above it, or presses beneath it. The elasticity and tenacity of these dams is so great that a steamer attempting to enter it is soon repelled by the elasticity of the grass, while men and even cattle can easily stay on the floating grass without danger. The river is thus soon transformed into a marsh covered with a mighty grass vegetation, and the water expands to the neighbouring *maije*, seeking its way through many new channels. It is obvious that those parts of the river where its bed is more definite are especially liable to be obstructed by grass islands which are formed in those parts of it where there is no definite frontier between running water and marsh. As to the appearance of *setts*, M. Marno is of opinion that they have become more frequent during these last years; he sees in their frequency a proof of the gradual levelling of the whole region by fluviatile deposits and of the general transformation of the whole of the region into marshes. The high floods of 1878 have largely contributed to the formation of numerous floating grass islands and to the formation of several large barriers across the river. Of course any hydrographical works for preventing the formation of grass obstructions would be very difficult now, owing to the scarcity of population; but the planting of papyrus palms along the banks of the chief channel would be most useful, as it would prevent the floating grass islands formed in the *maije* from entering into the main channel of the Nile.

THE WEATHER OF NOVEMBER, 1881

THE weather of November last has been in many respects so unusual as to call for a brief record of its chief characteristics. For thirteen months previously the immense majority of the depression-centres, or centres of the storms which swept across North-Western Europe, passed to the southward of the northern half of the British Islands, and many of them wholly to the south of these islands, with the inevitable result of unseasonably cold weather to the north of these storm tracts. But early in November an important change set in, and up to the time of going to press the change has been an enduring one, viz. the storms of North-Western Europe have swept eastward along tracts wholly to the westward and northward of the British Islands, with the necessary result of a temperature very greatly in excess of the average of the month.

From Buchan's isobars for the month we see that the mean increase of atmospheric pressure from the Butt of Lewis to Valentia, in the south-west of Ireland, is about 0·100 inch; but in November last the increase amounted to 0·348 inch, the means of these places being respectively 29·391 inches and 29·739 inches. The increase from the Butt of Lewes to Dover was still greater, amounting to no less than 0·605 inch, instead of 0·150 inch, the normal difference. It is premature to state the locus of the centre of this extraordinary barometric depression till fuller observations have been received; in the meantime, however, a position in the Atlantic, a little to westward of the Hebrides, may be provisionally assumed as the centre with but a small limit of error.

The most important result of this abnormal diminution of atmospheric pressure in the north-west, and rapid increase southward, has been a prevalence of winds from the Atlantic, characterised by a force and a persistency quite unprecedented during the last quarter of a century, with a distribution of temperature and rainfall over the British Islands very remarkable and in some respects strikingly abnormal. As these winds from the Atlantic swept across and reached the east of Scotland, their direction took a more southerly, and in the north a more south-easterly course.

Everywhere the temperature was abnormally in excess—the smallest excess, about 3°·5, being on the coast in the north; and the largest excess being in the interior, as happens with high temperatures at this time of the year, since in such circumstances the cooling through terrestrial radiation is relatively much less than usual in strictly inland situations. The greatest excess would appear to have occurred in the higher parts of the valleys of the Thames and Trent in England, and of the Clyde and Tweed in Scotland, where it reached, or closely approached to, 6°·5 above the means of November for the respective districts. In London and Edinburgh the excess was 6°·0.

On comparing this excess for Edinburgh with the observations made in that division of the British Islands during the past 118 years, or since 1764, the mean temperature of November, 1881, is absolutely the warmest on record, the nearest to it being an excess of 5°·5 in 1818, and 5°·2 in 1792 and 1847. As regards London, the temperature of November 1818 and 1852 somewhat exceeded that of 1881, the former of these years being also unusually warm in Edinburgh, whereas there November, 1852, was colder than the average.

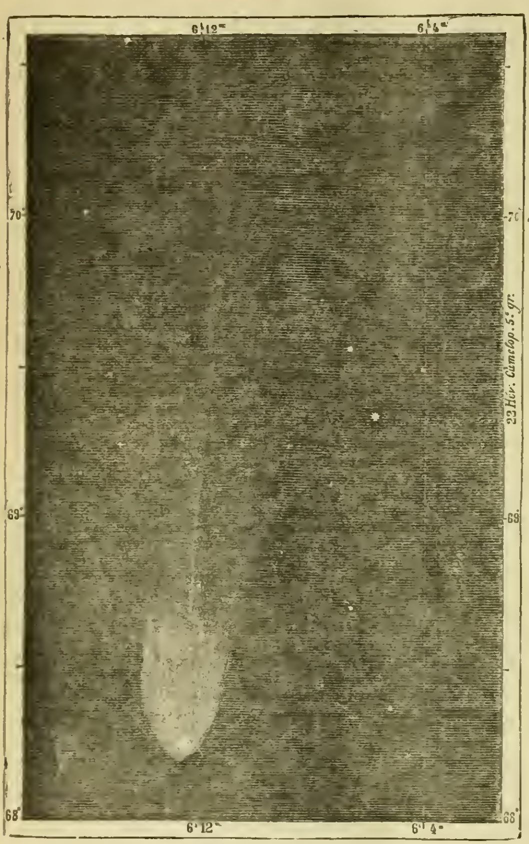
The distribution of the rainfall was strikingly unequal in North Britain, or where the prevailing winds curved round more towards a southerly and south-easterly direction. On the high ground sloping up on both sides to the Lead and Lowther Hills the rainfall at many places considerably exceeded double the average of the month. On the other hand to the north of the Cheviots and Lammermoors the rainfall was under the average, the amount in East Lothian being less than half the average. Crossing the Firth of Forth, we meet an extensive tract reaching as far as the high grounds of the Grampians, where the rainfall was excessive, amounting in West Perthshire and Upper Dee to more than double the average. Again, beyond the Grampians, and including the whole of the North of Scotland, northward and westward to the extreme north of the Lewis, the fall was less than the average, the amount on the south shores of the Moray Firth being only half the average. It is worthy of remark that this distribution of the rainfall is precisely the opposite of what occurs with weather very similar, but with the single difference of the south and south-east winds being replaced by north and north-east winds, in which the foreshores of the Forth, Moray, and Pentland Firths facing the north are deluged with rains. In the east of England the rainfall was, generally speaking, light, but it was above the average in Ireland, and in a less degree in the west of England.

Out in the Atlantic, along the great routes of traffic to New York, the month would appear to have been characterised by an almost unbroken succession of storms, several of which, if judged by their destructive effects on even well-appointed sailing-vessels and steamers, were memorably great storms. The storm which reached the west on the 21st will be long remembered for the furious winds and extraordinarily high and destructive tides which accompanied it; and the storm of Sunday, the 27th, for its most disastrous effects, particularly in the south, and for the unprecedentedly low readings of the barometer in the north-west and north of Scotland, where, over a wide area and for a considerable time, atmo-

spheric pressure was under 28·000 inches, the lowest being 27·865 inches at the Butt of Lewis, at which low point the barometer stood from 4.30 to 7 a.m. of the 27th.

PHOTOGRAPH OF COMET B, 1881

PHOTOGRAPHY has already proved of great service to astronomy, and its value in reproducing with unfailing accuracy and permanently preserving an observation is evident. It is long since the art has been utilised in the observation of eclipses; with De La Rue's



Facsimile of a photograph of the Great Comet B 1881, taken at the Observatory of Meudon, July 1, 1881.

photographs of the moon we are all familiar, while those of sun-spots have recently attained a rare degree of perfection. And now at last photography has been successfully applied to comets by Dr. Janssen at the Meudon Observatory, Paris. The woodcut we give to-day of Comet B is from our French contemporary *La Nature*, and has been revised by Dr. Janssen himself, so that it may be accepted as a faithful reproduction of his photograph. Dr. Janssen also gives some interesting details as to the circumstances under which the photograph of the comet was taken. It was obtained on July 1, 1881, at 0h. 37m. under the following conditions:—The operators used a telescope of half a metre aperture and 1·60m. focal length. The plates of gelatino-bromide of silver, extra sensitive, were manipulated and developed in darkness. The time of exposure was thirty minutes. Arrangements were made to counteract the proper movement of the comet in addition to the diurnal movement. The impression of the tail extends to more than 2½ degrees; and the head of the comet assumed very great dimensions; but the details of the tail show that the movement of the instrument has kept pace with that of the object. The rectilineal rays are a revelation of the photograph, which moreover shows some very small stars not seen in any celestial atlas.

ON ARTIFICIAL DEFORMATION OF THE HUMAN SKULL IN THE MALAY ARCHIPELAGO

MR. CROCKER mentioned, in the *Proceedings* of the Royal Geographical Society of London in the beginning of this year, that the Milanows, a coast tribe in North-West Borneo, between Bruni and Tandjong Agri, Sarawak, flatten their heads by means of pressure in infancy, but not to the extent of disfigurement, a custom, Mr. Crocker adds, which is peculiar to this tribe, and occurs nowhere else in the Archipelago.

This last statement induces me to show that, on the contrary, the custom is spread through the whole vast area from Sumatra to Timorlaut, and north to the Philippines; I even believe that it is not going too far to say that almost no large island within this region can be found, where the custom of artificial deformation of the skull is not, or has not been in use. Having treated of the geographical distribution of the custom all over the globe in a paper "Ueber künstlich-deformirte Schädel von Borneo und Mindanao im königl. anthropologischen Museum zu Dresden, nebst Bemerkungen über die Verbreitung der Sitte der künstlichen Schädel-Deformation," I shall restrict myself here to the Malay Archipelago.

To begin with Borneo: I procured last year a skull from Sarawak, over which a basket of ratan was so closely twisted, that it could but with difficulty be freed. When taken out I immediately perceived that it must have been artificially deformed; the whole occiput was flattened in a way which could not have been due to other causes. This skull (Fig. 1) must have hung a long time in the basket over a fireplace, for it was blackened and dusty all over. The direction of the pressure in youth had been, besides perpendicularly from behind, from the right side and below, for the right basal portion is totally distorted.

Wishing to know something positive as to the custom in Borneo, I wrote to the well-known naturalist and collector, Mr. Everett, who is now living in Papan, North Borneo, and who sojourned a long time in Sarawak before. Mr. Everett had the kindness to answer, in a letter dated August 25, 1880: "With regard to the custom of flattening the skull, I have heard that it is

practised by the Kanowits and Malanau tribes in Sarawak." In consequence of this information I asked Mr. C. C. de Crespigny of Sarawak, a gentleman who has already (in 1876) published some account of the Malanaus in the *Journal* of the Anthropological Institute of Great Britain, to forward, if possible, the instrument with

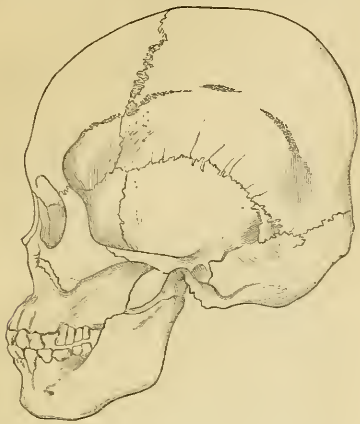


FIG. 1.—Artificially deformed skull from Sarawak, Borneo.

which the artificial deformation is effected; and Mr. de Crespigny was so obliging as to fulfil my wish and to write on April 8, 1881: "I am sending by this post the little instrument you desired me to procure for you, used by the Malanau women in flattening the heads of their female children, in order that their appearance may correspond with their parents' idea of beauty."

The instrument (Fig. 2) is by no means roughly made, but so well adapted to the purpose that one must regard it as the result of the exertions of many generations. I am sorry that Mr. de Crespigny, to whom I am so much indebted, did not add a note as to the way in which the apparatus is applied to the child's head. I suppose that this is wrapped up in cushions and laid with the occiput on the square wooden part of the apparatus *a*; the bandage *b*, made of blue cotton, then being tied round the forehead, the bandage *c* over the whole head from the forehead to the occiput, and the threads, fastened at the end of *c*, drawn through the holes in *a*, and finally through the square hole of a Chinese coin, behind which they are knotted together with some glass beads. Two sets of holes in the longitudinal part of the wooden instrument allow the degree of pressure to be regulated. The apparatus is very accurately cut and polished. The length is 325 millimetres, length and breadth of the square middle part 90 and 60 mm. respectively, the length of the frontal band 315, of the sagittal band 190 mm.

In the mean time Prof. Flower, in his interesting essay ("Nature Series"), "Fashion in Deformity, as illustrated in the Customs of Barbarous and Civilised Races," mentioned, on the authority of Mr. H. B. Low, that in the neighbourhood of Sarawak the deformations are made purposely; and I therefore do not doubt that the custom is a common one in that country. Perhaps a very asymmetrical skull in the Vrolik collection of Amsterdam, from Banjermassin in South-Eastern Borneo, may be artificially deformed. I have not yet succeeded in finding another trustworthy report of the same custom in Borneo from other tribes, but am sure that we shall soon hear from other quarters of the same, attention once being directed to the question.

Proceeding from Borneo to the Philippine Islands in the north, we have ample materials from that group of islands. I procured, in the year 1872, in the island of

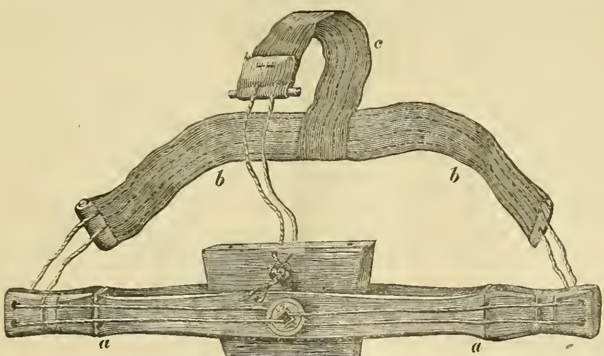


FIG. 2.—Instrument for deforming the heads of infants, used by the Malanaus on Borneo.

Luzon, in the province of Bataan in Zambales, from graves in the forest, twelve skulls of Negritos, nearly all of which are more or less artificially deformed. Prof. Virchow is of opinion that the flattening of the occiput and the broadening of the hinder parts of some of the skulls is so strong as to make them in a high degree similar to certain deformed skulls from Peru. The flattening of the occiput is very obvious in some of the portraits of Negritos which I sketched on the spot, three of which are represented in Figs. 3–5.

It has been known since the seventeenth century that the custom is in vogue on the Philippine Islands. M. Thévenot in his valuable work, "Relations de divers Voyages curieux" (1664), in the part, "Relation des isles Philippines faite par un Religieux qui y a demeuré 18 ans," says in his old French: "Ils auoient accoustumé dans quelques-vnes de ces Isles, de mettre entre-deux ais la teste de leurs enfans, quand ils venoient au monde, et la pressoient ainsi, afin qu'elle ne demeura pas ronde, mais qu'elle s'estendit en long; ils luys aplatissoient aussi

le front, croyant que c'estoit vn trait de beauté le a'auoir ainsi." Artificially deformed skulls have further been procured by Doctors Schetelig and Jagor, about the year 1860, from caves on the islands of Samar, Leyte, and Luzon, and from Bicol and Cimarron graves (Cimarrons being hybrids between Negritos and Bicols) in Albay on Luzon. An Igorrotes skull from West Luzon, which I brought home, is, according to Prof. Virchow, so small as to suggest that it has not its natural form. From the south-west of the large island of Mindanao Professors de Quatrefages and Hamy have described two deformed Hilloonas (Negrito?) skulls, and the Dresden Museum possesses two enormously deformed skulls from a cave

FIG. 3.

FIG. 4.

FIG. 3.—Negrito, man, Luzon. FIG. 4.—Negrito, young woman, Luzon.

near Lianga in South-East Mindanao, procured by Prof. Semper.

One of these (Fig. 6) has been pressed from the front to the occiput for the special purpose, at the same time, of flattening the whole head. The hinder parts of the parietals slope down nearly perpendicularly at the tubera, and the occiput has no prominence at all. The other (Fig. 7) has been acted upon from below and behind and from the front, and, at the same time, by a broad bandage across the parietals behind the coronal suture, where a deep depression occurs. The tubera parietalia are blown up similar to those of skulls from the Gulf of Mexico,

FIG. 5.—Negrito, man, Luzon.

which Dr. Gosse called "têtes trilobées." Therefore it cannot be doubted that the custom has been, and is in use nearly everywhere on the Philippine Islands.

Not less so in the island of Celebes, which is nearly united to the Mindanao by some smaller groups of islands, which may be considered as stepping-stones. Mr. Riedel of Gorontalo informed us in the year 1871 that the inhabitants of Buol, Kaidipan, and Bolang-itam in North Celebes wind round the heads of their children the smoothed bark of the Lahendong tree, and afterwards press it between two wooden planks, which are fastened in front and occiput. The heads are broadened by this process, which is considered a peculiar attraction; the child is treated in this way from four to five months. Mr. Riedel even forwarded a model of a cradle, as used in Buol for deforming the heads of noblemen's children; the instrument remains fastened for six to eight weeks, and the children are only freed every second day to be bathed. Mr. Wilken recorded the same custom from

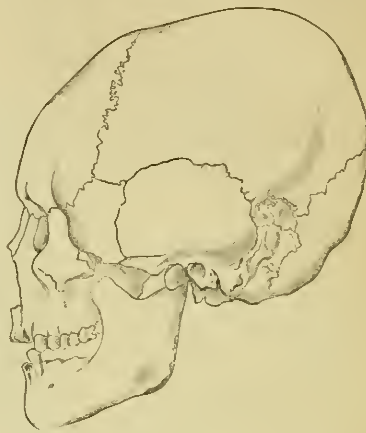


FIG. 6.—Artificially deformed skull from a cave near Lianga, Mindanao.

Passan and Ratahan in the Minahassa, in North Celebes, the last-named spot being quite near Panghu, a place where Mr. Wallace made one of his celebrated collections ("Malay Archipelago," vol. i. p. 408). Mr. Wilken says that the process is continued from fifty to sixty days, and that the flattening of the forehead is called "taleran," the common people practising it very generally now. The

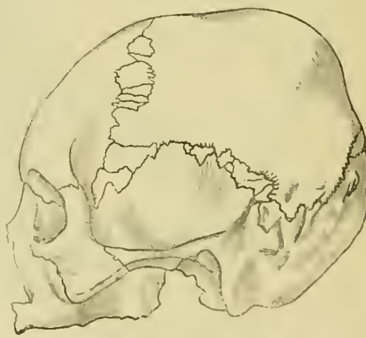


FIG. 7.—Artificially deformed skull from a cave near Lianga, Mindanao.

same custom is in use still with other tribes of the Minahassa and the surrounding countries. Finally, Mr. Riedel could prove it among peoples called Toragi, Tondai, Torau, and Tomori in Central Celebes, where the heads of the boys are pressed laterally and from behind, "that they may become good warriors," and the foreheads of the girls broadened "to increase the beauty of the

women"; the process is continued from four to five months.

Besides this direct information there is an artificially deformed skull of an "Alifuru," from Celebes in the Hildesheim Museum; and of a Bugis from South Celebes, in the Vrolik Collection of Amsterdam, the descriptive catalogue saying: "Plus que tout autre ce crâne fait l'effet d'avoir été comprimé à son jeune âge par une grande force agissant d'arrière en avant." Dr. Barnard Davis remarks on a skull from Makassar, in South Celebes: "Has an extensive parieto-occipital flattening; the result is a brachycephalism which scarcely seems compatible with undesignedness." No doubt this is proof enough to justify the opinion that the custom is spread over the whole island of Celebes.

As to Sumatra Marsden has often been quoted, "that the women have the custom of compressing the heads of children newly born, whilst the skull is cartilaginous, which increases their natural tendency to that shape."

From Java it has been made known by Professors van der Hoeven, Swaving, Halbertsma, and Zuckerkandl, that a considerable proportion of the skulls from that island are asymmetrical, viz. 60 per cent., and that of three awry skulls two are flattened on the left side. Prof. Halbertsma supposes that this asymmetry comes from the child's position on its left side while sleeping; Prof. Zuckerkandl is of opinion that it comes from pressure during birth; whereas Prof. Rolleston, whose premature death we deeply deplore, expressed the following view:—"The wish to keep the right arm free causes the left arm to be usually employed for carrying a child; the pressure of a sling used in aid of the left arm would come to bear mainly on the left side of the child's head, and the observed flattening would thus be accounted for." However this may be, the asymmetry does not appear to occur as a result of designed deformation; but Dr. Swaving concedes that the midwives try to change the form of the head in the newly-born child by pressure; Dr. Gosse saw a Javanese skull with occipito-nasal deformation, and perhaps this question must be more thoroughly studied on the spot to get a better insight.

Dr. Davis says of a skull from the island of Bali:—"Approaches closely to the American crania deformed by occipito-frontal pressure; it is so great as to render it very difficult to look upon the distortion as unintentional."

The Dresden Museum possesses a skull from the island of Ceram, and another one from Boano, near Ceram, which appear to be artificially deformed; further, two skulls of the same kind from the island of Flores among ten specimens. Of a skull from the island of Timor, Dr. Davis says: "Of extraordinary form and proportions, being extremely brachycephalic, and exhibiting a large parieto-occipital flattening." Finally, the Dresden Museum recently got from the Timorlaut Island group two skulls which undoubtedly are artificially deformed.

I will not proceed further on to New Guinea, because this would lead me into the Papuan or Melanesian region, where, as well as on many islands of the South Sea, the custom prevails; but I only proposed to show its being far spread through the Malay Archipelago. I do not doubt that more information will come from this region, if only the attention of residents and explorers in future is directed to the question, and if more skulls are forwarded to scientific men and institutions.

A. B. MEYER

NOTES

EVERYTHING in connection with the Crystal Palace Electrical Exhibition appears to be progressing most satisfactorily. All the available space has been allotted to exhibitors, and many applications for room have had to be refused. The best positions have been given to the first applicants, and from appearances there is little doubt but that this exhibition will be a success. As an Electric Light Exhibition it will surpass that in Paris, because the peculiarities of the building permit direct comparisons being made, and allow of each different system having a portion of the building allotted to itself. Thus the whole of the nave will be divided off, each part to a different system, while all the different courts, the Alhambra Court, the Pompeian Court, and others, will have a separate and distinct system applied to its illumination. There does not appear to be in the world a building more suited for the display of the electric light than the Crystal Palace with the far-famed courts referred to. There is little hope of any show being made before the commencement of the ensuing year, but there is strong reason to believe that some portion of the building will be illuminated by the electric light at Christmas time. Not only has the Postmaster-General consented to make an extensive show, but the War Department have now agreed to exhibit, and there is every probability that this display will be most interesting. Had our War Department made an exhibition in Paris it would have undoubtedly outshone the displays of other governments in this section. A great feature of the exhibition will be the external exhibits. A tramway is about to be constructed along the whole terrace, on which a coach will run by the aid of Faure batteries. An electric railway, which was such an attraction at Paris, will continue to whirl passengers about by the energy produced by Siemens' currents. Although the exhibition will contain a great display of apparatus relating to all the applications of electricity, it will be an Electric Ligh Exhibition, and the numerous lamps and machines for the production of the light will be the great attraction to the public.

MR. LIVINGSTONE, Master of the Public Schools, Fort William, having kindly offered to the Scottish Meteorological Society to climb Ben Nevis once a month, whenever practicable, to read the thermometers left on the top of the Ben, made his first ascent on Saturday last. He left Fort William at 8.15 a.m., and returned at 4.5 p.m. The ascent to 2200 feet was easily accomplished, the real difficulties being encountered above this height, owing to the snow which covered the higher parts of the Ben. A shower of rain fell at the lake on the way up. At this point, as had been done by Mr. Wragge, observations were taken, and the temperature of the air found to be 37°·0, and that of the water 38°·3. On reaching the spring, which is 3363 feet high, the temperature of the air was 30°·0, and that of the spring 35°·6, or a degree higher than in the middle of June. The summit was reached at 1 p.m., the wind being north-west the temperature of the air 26°·5, and the plateau covered with snow to a depth of 2 feet. The protecting cage for the thermometers and other instruments was found all right. The maximum thermometer read 44°·0, and the minimum 14°·1—these being the extremes of temperature since Mr. Wragge made his last observation in the end of October.

IN a few days the Russian expedition to the mouth of the Lena to establish a magnetical and meteorological observatory on Weyprecht's plan is to start from St. Petersburg. The route is by rail to Nishni-Novgorod, thence by sleigh to Perm, by rail to Yekaterineburg, by sleigh to Irkutsk, where they are expected to arrive in January, and stay till May to complete their outfit, secure the services of five soldiers, and train them to meteorological observation. Meanwhile a barge is to be built or bought at Katschug, on the Lena, where the navigation of this river begins. The party, on descending the river, will stop for some time at Irkutsk, to make further preparations. The length of the route, and especially the difficulty of transportation by land without railways, make the Russian expedition the most difficult of the Arctic expeditions on Weyprecht's plan. Petroleum is wanted to give a good, clear light, and $2\frac{1}{4}$ tons of it will

have to be bought at Nishni-Novgorod, as this light is yet little used in Siberia. Besides the building of the houses, the food of the expedition, &c., all will be more difficult to obtain than the same articles wanted by an expedition sailing in ships. The sum of 42,000 roubles has been granted by the Russian Government. The idea of establishing a second station had to be abandoned, the money being barely sufficient for one station. If the Russian Government should give another sum for observations in high latitudes, a station will probably be established at Moller Bay, on the west coast of Novaya Zemlya. This station would be less expensive, there being always a possibility of reaching the place by ship. The expedition starting now takes two sets of meteorological instruments for establishing additional stations at Irkutsk and some point north of it. The chief of the expedition is Lieut. Jurgens, I.R.N.; he is well qualified to fulfil the arduous duties assigned to him. He will be accompanied by Dr. Bruge, medical assistant, and a meteorological assistant.

We direct the attention of our readers to the letter of the Rev. A. E. Eaton in to-day's NATURE, which has so important a bearing on the probable condition of Mr. Leigh Smith's expedition in the *Eira*. From Mr. Eaton's letter it is evident that Mr. Smith deliberately intended to winter at Franz-Josef Land; and to those who know him it is not surprising that he said little about it to his friends. This is also essentially the drift of a short notice on the subject in yesterday's *Times*, where, however, the very inconsequent conclusion is drawn "that a relief vessel should be sent out in the course of next summer by either Mr. Leigh Smith's relatives or the Government." There can be no objection to the relatives sending out an expedition, but so far as present evidence goes, a Government expedition does not seem to be called for.

The news lately received from the Behring Strait whalers discloses a very remarkable condition of things in the Arctic Sea this season. Capt. Williams, of the *Frances Palmer*, reports clear water in N. lat. 73° 30′ to the east of Herald Shoal, and the U.S. Relief-ship *Rodgers* got as far north as 73° 44′ on the west side of Wrangel Land. Other whaling captains assert that this year they went fully two degrees further north than their charts extended, and every one agrees that both the early and latter parts of the season have been open to a degree unparalleled in Arctic records. The Arctic basin has been found to be comparatively shallow, the depth being about twenty three fathoms. The gales which prevailed when the *Thomas Corwin* left the Arctic Sea in the early part of September broke up the ice further north, and the prevalence of northern winds no doubt accumulated it about the north coast of Wrangel Land, and prevented the boats of the *Rodgers* from actually circumnavigating the island. This year's exploring cruise of the U.S. steamer *Thomas Corwin* has been a very remarkable one. The most important event was the landing on, and partial exploration of, Wrangel Land, which Capt. Hooper renamed New Columbia. He discovered there a tolerably large river, which he named the Clarke River, and the course of which a party who landed at its mouth assert that they were able to trace for some forty miles into the interior. The *Thomas Corwin* appears to have had no difficulty in moving to and fro in the Arctic Sea, except early in September, when a second attempt was made to reach Wrangel Land, but failed through fogs and strong gales. Capt. Hooper visited Point Barrow, on the northern coast of Alaska, and found the ice some twenty miles off the shore.

Mr. W. H. Dall, of the U.S. Coast Survey, contributes to the *American Naturalist* for November a paper on the Chukchi and Namollo people of Eastern Siberia, which seems to have been called forth by some criticisms on the part of Lieut. Nordquist in a communication to the St. Petersburg Geographical Society, afterwards reproduced in our Geographical Society's *Proceedings*. If Mr. Dall replies to all his critics, he will next have to take up the subject of the currents of Behring Strait, for the American whaling captains assert that what he has written on this point is incorrect. Capt. Fisher, of the *Legal Tender*, indeed, says that Mr. Dall's observations extended only over a few days, and were made in an eddy current under the lee of the Diomede Islands.

News has been received by the Bremen Geographical Society that two walrus hunters have returned to Tromsö from Spitzbergen, who report that early in September they were fifteen miles north of the Seven Islands (north of Spitzbergen), and that they found the sea quite free from ice in a northerly direction.

On Monday next Mr. Clements R. Markham, C.B., will read a paper before the Geographical Society on the Arctic work of the present year.

Zoologists are indebted to Dr. R. W. Shufeldt, First Lieutenant, Medical Department, U.S. Army, for a highly valuable contribution to the study of the osteology of birds. He has written two essays in the United States Geological and Geographical Survey *Bulletin* of September, 1881—one on the "Osteology of the North American *Tetraonidæ*" (pp. 309–350), and the other entitled "Osteology of *Lanius ludovicianus excubitorides* (pp. 351–359), both illustrated by several plates; and we can only wish that every monographic essay which treats of the anatomical structure of a limited group of birds were written in such a careful and exhaustive manner. There is scarcely a bone which is not correctly figured, most of them life-size, although some might be a trifle more plastic. All of them are treated of separately, and an exact description is given of the general *Tetraonine* feature of the bones, and in instances where the representatives of the genera under notice are aberrant due attention is drawn to the fact. The author frequently refers to allied families, such as the Partridges and others, and throughout the whole paper we see that the work of previous anatomical writers is carefully taken into consideration; and as Dr. Shufeldt had a large series of specimens before him he was enabled to exclude any peculiarities which might have been attributable to malformation of the bones. So far so good; but descriptive anatomy is one thing, and comparative anatomy another. Whenever the author discusses some of the difficult questions of comparative anatomy, as he does more than once, being well aware of the points where there is still a problem to be solved, we are afraid we cannot follow his deductions. One of the figures in the first plate in the paper on the *Tetraonidæ*, and part of the letterpress, is devoted to a demonstration of the "four cranial vertebræ" with all their appendages and derivatives; but although the disarticulated segments are nicely grouped together on the plate, the conclusions he arrives at certainly contain some obvious mistakes. At p. 328, to the ribs generally known as "sterno-costal" the term "hæmal" ribs is applied. Again we are glad to find that the author admits the theory which considers the limbs with their girdles to be transformed and translocated gill-branch elements, but he goes too far. He seems to believe that the scapular arch originally belonged to and constituted the hæmal arches of the occipital vertebræ. Further on we are informed that we may consider the bones of the pelvic girdle to be the pleur- and hæmapophyses of some of the sacral vertebræ—*verbum sat*. We therefore regret that this essay on the *Tetraonidæ*, valuable as it is as a contribution to ornithotomy, should be handicapped by speculations so wild and so dangerous to the credit of comparative anatomy.

In his "Zur Aetiologie der Infectionskrankheiten," A. Weil states the cause of the decay of teeth, whether external or

internal, to be the Schizomycete *Leptothrix buccalis*, the mode of entry and propagation and the life-history of which he follows out in detail. The acids which occur in the mouth, especially lactic acid, while they may greatly promote the decay, cannot give rise to it. The Leptothrix can be readily recognised by its iodine reaction. The author considers further that in many cases diseases of various parts of the body can be distinctly traced to excretions from the mouth and teeth. Other observers had already traced a connection between decayed teeth and septic abscesses, in which was found a fungus similar to that which occurs in decayed teeth.

THE balance has been applied by Herr v. Jolly, at Munich, to the problem of gravitation thus (*Wied. Ann.* No. 10): The instrument was placed in the upper part of a tower, and from each of the scales depended a wire (through a zinc tube) having a second scale at the lower end, 21·005 m. below. These lower scales were 1·02 m. from the ground, so that a lead ball one metre in diameter might be brought under one of them. A body brought from an upper scale into a lower one has an increase of weight corresponding to its degree of approach to the earth's centre and to the increase of acceleration. When the lead ball is brought under the same lower scale its pull is added. The difference of the increments of weight, with and without the lead ball, indicates the amount of pull of the latter, and the quotient of this pull and that of the earth alone furnishes a means (with the law of gravitation) of comparing the density of the earth with that of the lead, and, the latter being known, of determining the mean density of the earth. Referring to the original for details, we merely state that the author finds the mean density 5·692 (probable error not more than ± 0·068). This agrees more or less with other determinations; from the mean of those with the torsion balance it diverges about 2 per cent.

THE death is announced, at the age of eighty-nine years, of Jean Alfred Gautier, the *doyen* of science in Geneva, and one of the most active citizens of that city. M. Gautier belonged to a very old Genevese family, and displayed an early taste for science. In Paris he counted among his teachers such men as Laplace, Lagrange, Legendre, and Poisson, and in England he formed a life-long friendship with Sir John Herschel. When he settled down in Geneva from his travels, he carried on the work of the little observatory then existing at Geneva, and it was through his exertions that a much better one was built, though defective vision did not enable him personally to superintend it. M. Gautier was one of the earliest to discover a relation between sun-spots and terrestrial magnetism, and in many ways he laboured successfully to advance science in his native city.

WE learn also of the death of Dr. Chr. G. A Giebel, Professor in the Philosophical Faculty at Halle University, an eminent zoologist and geologist. He died at Halle on November 14. The death is also announced, on November 11, of Prof. Engelhardt, a well-known Danish antiquarian, and secretary of the Society of Antiquaries at Copenhagen; and of Prof. Paul-Günther Lorentz, a well-known German authority on mosses; he died at Concepcion del Uruguay at the early age of forty-six years.

THE earthquake of November 18 was noticed in Switzerland, shocks being reported from Ragatz and St. Gall. A great area, comprising Westphalia, Hessen-Nassau, and Belgium, was also visited by this phenomenon; it was noticed at Münster, Marburg, Brussels, Tournai, and Liège and Metz. On November 24 at 11 p.m. a shock was observed at Dedenborn, near Montjoie (Rhenish Prussia), and two shocks at Pergine (Southern Tyrol) early on November 20.

IN February next a private scientific exploring tour to Persia will be undertaken by a Viennese medical man, Dr. Polak. He will lead the expedition himself, and will be accompanied by a geologist and a botanist. All expenses will be defrayed by Dr. Polak.

MOST of the members of the Royal Commission on Technical Instruction have returned to England; they have, we understand, accumulated a mass of valuable information in the course of their preliminary tour, which has included the principal centres of industry in France.

THE dinner in commemoration of the Brewster Centenary will take place in Edinburgh to-morrow.

PROF. J. G. MCKENDRICK has been appointed Fullerian Professor of Physiology for three years at the Royal Institution.

THE Vienna Geographical Society will celebrate the twenty-fifth anniversary of its foundation on December 12 and 13 next.

WE have received from the Parkes Museum a copy of the artistic certificate of awards in connection with the International Medical and Sanitary Exhibition, lithographed from the original design by Mr. Cave Thomas. The certificates are now being distributed. The following facts are of interest:—Exhibitors from different parts of the United Kingdom, 414; exhibitors from abroad, 88; making a total of 502 exhibitors, of whom 258 received either awards of the first class, or awards of merit.

A SURVEY party, under Col. Branfil, has left Calcutta for the purpose of verifying and completing the survey of the Megin Archipelago. The work, including the measurement of the base line, is expected to occupy about six months. Dr. Anderson, Superintendent of the Indian Museum, has accompanied the party and will take the opportunity of instituting a thorough investigation of the local fauna.

THE German Government contemplates sending out two expeditions for observing the transit of Venus in 1882: one to the mouth of the La Plata River, the other to Magelhaen's Straits or the Falkland Isles. The expedition of 1874 cost the Government 600,000 marks (30,000*l.*), the one of next year is estimated to cost only 195,000 marks (9750*l.*).

M. MOUCHEZ, director of the Paris Observatory, is making arrangements for taking meteorological observations at an elevation of 2300 metres by means of a captive balloon. The balloon will be charged with ordinary coal-gas. These observations are intended to facilitate the calculation of atmospheric refractions.

DURING November, twenty-two earthquake shocks have been observed in various parts of Switzerland. They seem to have been most numerous in the neighbourhood of Schaffhausen.

A FINE monument has been erected at Bonn on the tomb of the eminent geologist, Prof. Jakob Nöggerath, who died on September 13, 1877. The sculptor is Herr Albert Küpper.

THE preliminary earthworks for the erection of the monument in memory of Justus von Liebig have been begun on the Maximiliansplatz at Munich.

M. TISSANDIER has organised a private company to prosecute his experiments with an electric directing balloon.

SOME of our readers may be glad to know that King's College, London, has a Science Society which meets on Wednesdays at 8 p.m. during term, for the purpose of reading papers on, and for the discussion of, scientific subjects. The papers, we are glad to learn, are generally experimentally illustrated.

DR. TAYLOR, curator of the Ipswich Museum, was on Saturday afternoon presented with a purse of 660*l.*, accompanied with a handsome clock and gold watch for Mrs. Taylor, in recognition of his labours in connection with the museum, and of his annual course of scientific lectures, which for a number of years he has delivered in Ipswich without any emolument. Sir Richard

Wallace presided on the occasion, accompanied by Lady Wallace, and there was a large company present.

A TRAIN of Pullman carriages lighted by electricity has begun to run between London and Brighton.

THE Risikopf, on which the landslip occurred that recently overwhelmed the village of Elm in Switzerland, is being bombarded by heavy artillery in order that all the loose portions may be detached and thus prevent any future catastrophe.

EISENACH is to have an electric railway from the station to the Wartburg Castle, if the Royal permission can be obtained.

THE *British Almanac and Companion* for 1882 contains a summary of Science for 1881 by Mr. J. F. Iselin. It is necessarily meagre, but Mr. Iselin has selected some of the leading points; the geography is pretty full.

THE additions to the Zoological Society's Gardens during the past week include a Black-eared Marmoset (*Hapale penicillata*) from South-East Brazil, presented by Mrs. George Willins; a Tawny Eagle (*Aquila nævioides*) from South Africa, presented by the Hon. — Southey; a Grey-breasted Parrakeet (*Bolborhynchus monachus*) from the Argentine Republic, a Black-headed Conure (*Conurus nanday*) from Paraguay, presented by Mr. J. Lloyd; two Talpacoti Ground Doves (*Chamæpelia talpacoti*) from Para, a Plumbeous Snake (*Oxyrrhopus plumbeus*), two Taraguira Lizards (*Taraguira smithi*), a —— Tree Frog (*Hyla*, sp. inc.) from Brazil, presented by Dr. A. Stradling, C.M.Z.S.; a Red-faced Spider Monkey (*Ateles paniscus*) from Guiana, three Red-billed Tree Ducks (*Dendrocygna autumnalis*) from South America, a Vinaceous Amazon (*Chrysotis vinacea*) from Brazil, a Redshank (*Totanus calidris*), two Dunlins (*Tringa cinclus*), two Razorbills (*Alca torda*), a Grey Plover (*Squatarola helvetica*), a Curlew (*Numenius arquatus*), British, purchased; a Geoffroy's Dove (*Peristera geoffroii*), bred in the Gardens.

THE ROYAL SOCIETY—ADDRESS OF THE PRESIDENT

II.

AFTER the Congress one of the most remarkable events during the present year has undoubtedly been the Electrical Exhibition in Paris. I do not of course purpose to describe it, as many of our Fellows visited it; and full descriptions have reached us through various channels. One point, however, must have struck those who examined any considerable number of the objects; and this I mention, not as in any way disparaging them, but rather as illustrating the stage to which electrical science has attained; namely, that while the assemblage of instruments and appliances was in every way remarkable, and while very great ingenuity and skill had been expended on their contrivance and construction, yet the amount of novelty in the principles involved was comparatively small. Of new combinations, improved methods, and adaptations in detail there was abundance. Some of them even removed former inventions from the category of curiosities to that of instruments for practical employment; or enlarged their sphere of utility from that of the laboratory to that of every-day use. But such is the mass of fruitful matter which science has furnished to the mechanician and constructor, that we might almost wish, from the point of view of the latter, that they may have time to work out more fully than has yet been done, the results of science, before they are called upon to elaborate any fresh materials.

It is now proposed to repeat as far as may be this Exhibition at the Crystal Palace; and the energy with which the proposal has been taken up, and the response with which it has met in many quarters, appear to justify sanguine expectations of its success, at all events from a practical and popular point of view. From the side of science it would doubtless have been far more interesting to look forward to a fresh exhibition, either here or elsewhere, of the progress of electricity after an interval of two or three years. But there is nothing in the present undertaking to interfere with the more advanced project, if, after some such period as that indicated, circumstances should prove favourable. In the mean time it must be remembered that there are very many persons to whom the Paris Exhibition would have proved both interesting and instructive, but who, from one cause or another, were prevented visiting it. Besides this, there are not a few commercial, and even municipal, bodies desirous of adopting some of the modern applications of electricity, but who would be more ready to avail themselves of them after a personal inspection of the instruments and of their mode of action. From this point of view the exhibition may fairly be expected to give considerable impulse to the adoption of electrical appliances in fresh quarters.

But even over and above this practical aspect of the undertaking there may still have been, at the epoch of the Paris Exhibition, some results on the eve of achievement, some remedies for defects, sufficient to transform a doubtful into a certain issue, or even a failure into a success; some steps which may open out new questions, or serve as a departure for new investigations in the subject of electricity. If such should be the case, even science may derive substantial benefit from the proposed undertaking.

But the present year has been rendered generally remarkable, amongst other things, by the multiplicity of its congresses. Apart from those which are concerned with subjects not coming under the head of "Natural Knowledge," there have been held the annual meetings of the British Association, and of the Iron and Steel Institute; the International Medical Congress, in London; the special Congresses on Electricity and on the Transit of Venus, in Paris (mentioned above); that on Geography in Venice; that on Geology in Bologna, and others.

Among all these the International Medical Congress, which this year met in London, stands conspicuous. The work of that meeting showed that the study of medicine by the real workers is, in every part, even the most practical, pursued in a thoroughly scientific spirit; that facts are industriously collected, and patiently grouped and compared; and that conclusions are, if sometimes hastily drawn, yet very cautiously accepted. And there was ample evidence that help, whether in apparatus or in knowledge, is eagerly accepted from all the other sciences, whether their range be far from, or near to, the biological. In short, in the opinion of those best qualified to form a judgment, it is not too much to say that the whole tone of the proceedings of the Congress, though chiefly concerned with practical questions, was, in the best sense, even in the sense which the Royal Society would give to the term, scientific.

Several of the societies meeting annually, or at longer periods, have organisations which, during the intervals between two successive meetings, do useful work. But in all cases the meetings form the most prominent, if not the most important, feature of their life; and, speaking particularly of the meetings themselves, the question has more than once been raised whether they continue to justify the efforts necessary to bring them about. It has been argued that, so many are the scientific periodicals in every civilised country, that all the papers of importance communicated to the meetings would under any circumstances be published in some place or other. Again, it has been urged that, so numerous are the centres of science, so many the means of communication both between places and between persons, that the necessity for these gatherings has, in the natural course of events, become superseded. The time which such meetings and the preparation for them involve, and the trouble which they entail on men already burdened with much work, have also been pleaded on the same side, and objections have been taken on the ground of the useless and irrelevant matter which is too apt to crop up on these occasions. These arguments are certainly not without weight; but there is still another side to the question. It is indeed quite probable that all the more important papers would be published even if the meetings never took place at all. But at these meetings there are usually a number of communications, many, but not all, of local origin, the production of which has been stimulated by the meeting itself; and a fair number of these may be reckoned on the side of gain. Again, it is true that the original idea of a parade or march-past of science, valuable enough when the provinces heard or saw little of science, has become less important now that provincial centres are to be found in almost every large town in the country. Nevertheless, the mere presence of some of the leading men stimulates dormant powers and encourages rising aspirations; and this perhaps all the more the

[1] Address of William Spottiswoode, D.C.L., LL.D., the president, delivered at the anniversary meeting of the Royal Society on Wednesday, November 30, 1881. Continued from p. 119.

case for the very reason that science and scientific names are no longer unknown. That most of the leading men have opportunities of meeting from time to time, and for scientific purposes, is certainly true; but that they should meet also on occasions when science is not too formal, is a thing which has its uses. And a concurrence of minds more numerous and more diversified than usual is sure to be fruitful of results. The whole advantage of these meetings, however, depends ultimately and fundamentally on the presence of a strong scientific element, which, from its own mere dignity and character, will repress all that is unworthy and will leaven the whole lump. Acting on this principle as a scientific duty, many good men have attended these meetings; and although they may have approached them with some degree of reluctance, few who during their attendance have taken their fair share in the proceedings, have come away without having derived a more favourable impression than that with which they entered.

Of such gatherings, the late meeting of the British Association at York was, if I may be permitted to express an opinion, a pattern and exemplar. And although it cannot be expected that in every year there will be so strong a muster as on the occasion of the fiftieth anniversary, yet all well-wishers of the Association must feel that it has entered upon its second half century with vigour and with dignity, and that it now remains only for its future supporters to maintain the high standard with which it has been handed down by those who have gone before.

It may be a matter of regret, although doubtless inevitable, that the same causes which have affected the social, the intellectual, the industrial, and the political life of our generation, and have made them other than what they were, should affect also our scientific life; but, as a matter of fact, if science is pursued more generally and more ardently than in former times, its pursuit is attended with more haste, more bustle, and more display than was wont to be the case. Apart from other reasons, the difficulty, already great and always rapidly increasing, of ascertaining what is new in natural science; the liability at any moment of being anticipated by others, constantly present to the minds of those to whom priority is of serious importance; the desire to achieve something striking, either in principle or in mere illustration; all tend to disturb the even flow of scientific research. And it is perhaps not too much to say that an eagerness to outstrip others rather than to advance knowledge, and a struggle for relative rather than for absolute progress, are among the dangerous tendencies peculiar to the period in which we live. I do not, of course, for one moment mean to imply that this tendency universally prevails, for in Science as well as in other pursuits, I believe that the best of the present would well stand comparison with the best of the past, and that there are nowadays men in the mid-stream of life who are as little affected by the eddies and back-waters with which they are surrounded as were the giants of former days. Nevertheless the danger is a real one, and is to be met with at every turn.

But the part of Cassandra is neither agreeable to the player nor welcome to the audience; nor is it indeed necessary that I should play it; for, even although what I have said be true, it is still, I trust, not the whole truth. I have already spoken of noble exceptions; but although noble exceptions may go far to redeem the character of a nation or of a period, and example may have influences of which we hardly dream, yet for a general remedy I am more inclined to look to the natural course of events, and to what is often loosely spoken of as "things curing themselves." Such a cure may perhaps come about somehow on this wise. So multitudinous are the workers in every science, so numerous are the channels through which their discoveries are chronicled, that it is becoming every year more difficult for even the learned and the well-read to say what is and what is not new, or what has not been published before. Claims for novelty must, therefore, as time goes on, be put forward with greater and greater diffidence. The only originality that can be safely claimed will be originality on the part of the investigator; and the question of absolute priority must be left to the verdict of time and of that sifting process by which ultimately all discoveries will find their proper places in the Temple of Science.

When this stage is reached, and we are even now approaching it, the fever of to-day may in a great measure subside and give place to a more tempered, although still fervent glow of aspiration. The eagerness and haste to which we have become almost accustomed may be chastened by the reflection that questions of priority are not to be settled by a mere stroke of the pen, and that in the comparison of rival claims the question of the quality of work will undoubtedly arise and become interwoven with that of priority. And so in the end it may come to pass that a half understood experiment or a hastily drawn conclusion may avail less than ever for establishing a reputation, and that, even for the purpose of winning the race, it may be worth while to spend sufficient time in laying sure foundations and in building a superstructure commensurate with that on which it stands and well-proportioned in all its parts.

The transference of the Natural History Collections of the British Museum to the new building at South Kensington is still in progress. It is hoped that the building for the specimens preserved in spirits, as well as the fittings for the zoological department, will be so far completed as to allow of the moving of that department during the autumn of 1882. The lighting of the reading-room by Siemens' lamps is so far satisfactory, that it has been decided to keep that room open in future until 8 p.m., instead of 7 p.m. This change, it is hoped, will prove to be of substantial service to a large class of readers.

The Institution founded in 1851, under the title of the Government School of Mines and Metropolitan School of Science applied to Mining and the Arts, for the instruction of students in those branches of science which are indispensable to the Miner, the Metallurgist, the Geologist, and the Industrial Chemist, has this year been organised afresh, and, under its new title of the Normal School of Science and Royal School of Mines, adds to its former functions the training of teachers for the Elementary Science Classes under the Science and Art Department, the multiplication of which, in recent years, is a significant indication of the rapid spread of scientific instruction throughout the country.

The accommodation requisite for practical teaching being inadequate in all cases and totally wanting in respect of many of the classes, in the Museum of Practical Geology in Jermyn Street, and in the Royal College of Chemistry in Oxford Street, all the instruction, except that in Mining, has been transferred to the Science Schools at South Kensington. The staff of professors and lecturers has been increased, and provision has been made for the teaching of various important subjects, such as Mathematics, Drawing, Botany, and the Principles of Agriculture, which were either omitted, or insufficiently represented, in the original programme of the school.

Under its new organisation the Normal School of Science and Royal School of Mines will not merely supply from among its associates persons highly qualified to apply the principles of science to the Mining, Metallurgical, Chemical, and Agricultural industries of the country, and properly trained science teachers; but, through the exhibitions attached to the yearly examinations of the Science and Art Department, it will place within reach of promising young students in all parts of the country, whose means do not enable them to obtain the benefits of a University education, such a training as will enable them to turn their natural abilities to account for the advancement of science and the improvement of its applications to industry. Under the latter point of view, the instruction given in the Normal School of Science will lead up to the special technical training of the Central Institute of the Guilds of the City of London.

Under the auspices of the City and Guilds of London Institute, further progress has been made during the past year in the promotion of Technical Education. It will be remembered that the work at present undertaken by the Institute embraces the establishment of a Technical Science School in Finsbury, a Technical Art School in Kennington, a Central Institution or Higher Technical College in Kensington, the subsidising of existing institutions, affording facilities for Technical Instruction and the encouragement of existing classes in the manufacturing centres by the grants paid to teachers on the results of the Technological Examinations.

In May last the foundation stone of the Finsbury College was laid by H.R.H. Prince Leopold, and the new building, which will afford accommodation for the teaching of applied Chemistry, Physics, and Mechanics, will be finished early in next year. Notwithstanding the inadequacy of the present temporary accommodation, large numbers of students have availed themselves of the instruction afforded. The principles of Electric Lighting, and Transmission of Power, the making of Electrical Instruments, Coal Tar, and Spirit Distilling have been the subjects that have been chiefly studied during the past session.

Since October the classes that were previously conducted by the Artisans' Institute have been transferred to the Finsbury College.

The Institute has under its consideration the establishment of a School for Applied Art in connection with the Finsbury College. Acting on the general principle that every Technical School of this kind ought to provide, in addition to the general course of instruction, as applicable to different industries, special courses applicable to the staple industry of the district, the Council of the Institute are contemplating the establishment of classes in the Finsbury College adapted to the educational requirements of those engaged in Cabinet-making. With this object it will be necessary to attach a School of Design to the College.

The influx of pupils to the studios in Kennington have induced the Council to vote a sum of money for the extension of the building in which the Art School of this district is conducted. These new buildings are nearly completed, and will afford accommodation for Classes in Modelling, Design, and Wood Engraving,

The building of the central institution, which is to be in the first place a school for the training of technical teachers, has been commenced. The first stone was set in July last by H.R.H. the Prince of Wales, who is now the President of the Institute. The plans of this building show accommodation for the teaching of the different branches of Physics in their application to various industries, of Chemistry as applied to trade purposes, and of Mathematics and Mechanics in their application to Engineering. A good engineering school, containing workshops, well supplied with machinery and collections of mechanical instruments and models, such as exist in numerous Continental cities, seems likely to be obtained for London on the completion of this building.

This Institute has done much towards the encouragement of technical instruction in provincial towns, where it is most needed, by its system of annual examinations. In the examination held in May last, 1563 candidates presented themselves, in twenty-eight subjects, from 115 centres, and of these 895 passed. A close connection is being established between the several technical schools which are being now opened in Lancashire and Yorkshire, and the City and Guilds of London Institute. The demands made upon the Institute by Chambers of Commerce in different parts of England satisfactorily indicate the usefulness of this part of the Institute's work.

The programme of Technological Examinations for 1881–82, just issued, shows thirty-two subjects in which examinations may be held, some of which are divided into four or five branches, so that they may be better adapted to individual industries. Whilst attention has in this way been given to the details of different trades, the attempt has been made to secure from candidates passing the Institute's examinations a general knowledge of the principles of their subject and of the relation of closely connected industries with one another.

In order to secure in future efficient teachers, the Council of the Institute have determined after March next not to register as teachers any persons except those who have passed the Institute's Honours Examination, or such as already possess special or distinct qualifications.

The interest which the subject of technical education is beginning to arouse has led to the appointment by the Crown of a Commission to inquire into the education of the industrial classes in England and in other countries; and the City and Guilds of London Institute is represented on this Commission by Prof. Roscoe, who, as President of the Chemical Society, occupies a seat on the Executive Committee, and also by Mr. Philip Magnus, its director and secretary. The Commissioners are at present engaged in making a tour of inspection in France, a section of them having already visited some of the principal technical schools and factories in the north of Italy.

In Meteorological Science the present year has been marked by the publication of an important work ("Die Temperatur Verhältnisse des russischen Reichs," St. Petersburg, 1880), by Prof. Wild of St. Petersburg, on the Temperature of the Russian Empire, embodying, in charts and tables, a great amount of information, hitherto either inaccessible or existing only in scattered memoirs, relating to the meteorology of the vast tracts of Northern Asia. As an interesting particular result it may be mentioned that Prof. Wild has transferred the "Siberian pole of cold in winter" from the neighbourhood of Jakutsk to a point somewhat further north, lying on the Arctic Circle in (about) E. longitude 125°. At this centre of maximum cold, round which the isotherms lie in fairly regular ovals, the mean temperature in January sinks as low as −54° F., the mean temperature at Jakutsk being 11° higher. In close relation to the phenomena exhibited by these charts, Prof. Wild, in St. Petersburg, has been led to study the connection between areas of permanent high or low mean pressure on the one hand, and areas of permanent high or low mean temperature on the other; and he has found this connection to be of the same kind as that known to exist in the case of the shifting areas of high or low pressure, and high or low temperature, which determine the changes of weather. M. Léon Teisserenc de Bort, in Paris, has also investigated the same subject.

The Meteorological Office has completed during the year two works of some interest, which are now ready for immediate publication. The first consists of tables of the Rainfall of the British Isles, prepared at the request of the Council of the Office by Mr. G. J. Symons, F.R.S. These tables include the monthly results recorded at 367 stations in the United Kingdom, being all those for which it was possible to obtain series of observations maintained continuously during the last fifteen years. The second is a volume of charts (with an introduction and explanations) illustrating the meteorology of an ocean district specially important to seamen—that adjacent to the Cape of Good Hope. Some points of novelty are presented by the charts. For example, a new form of "wind-rose," invented by Mr. F. Galton, F.R.S., has been employed, which offers some theoretical advantages over those previously in use, being intended to represent, with geometrical precision, the probability (deduced from the observations) that, in a particular place and at a particular season, a wind blowing between any two given points of the compass will be experienced. Again, for the first time in marine meteorology, the wind observations have been "weighted" with the view of neutralising the tendency to over-estimate the frequency of adverse winds, which has been found to affect meteorological charts injuriously. The work brings into clear relief the most interesting physical feature of the district—one indeed already well known—the intermingling of hot and cold water, brought by the Agulhas and the South Polar currents respectively, and supplies strong evidence for the belief that this intermingling has a large share in producing the atmospheric disturbances so common in the region in which it occurs.

In my Address to the Society in 1879, I stated that an International Conference of a semi-official character had been held, with the view of establishing for one complete year a circle of meteorological observations round the Arctic regions of the globe. Notwithstanding the lamented death of Lieut. Weyprecht, the gallant young discoverer of Franz-Josef Land, by whom the proposal had been originated, it would seem that the efforts of the Conference are likely to be crowned with success. The following stations have already been undertaken by different Governments:—Point Barrow and Lady Franklin's Bay in Smith's Sound, by the United States; West Greenland, by Denmark; Jan Mayen, by Austria; Mossel Bay and Spitzbergen, by Sweden; Bossekop, by Norway; Nova Zembla, by Holland; the Mouths of the Lena, by Russia. The Conference has also been led to hope that the Canadian Government may reinstitute observations at Fort Simpson, and that the Government of France may organise a simultaneous meteorological expedition to Terra del Fuego. It is arranged that the observations should begin as soon as possible after August 1, 1881, and should continue to September 1, 1883.

In astronomy Mr. Gill has completed his discussion of the extensive series of heliometer measures of the parallax of Mars, which he made at Ascension in 1877, and has deduced the value 8″·78 for the solar parallax, corresponding to a mean distance of 93,080,000 miles from the earth to the sun. A value of the solar parallax has also been derived by Mr. D. P. Todd, from the American photographs of the transit of Venus, 1874. The result for the parallax is 8″·883, corresponding to a mean distance of 92,028,000 miles.

A valuable contribution towards the determination of the moon's physical libration has been made by Dr. Hartwig. From a series of forty-two measures made with the Strassburg heliometer he derives values for the physical libration and for the inclination of the moon's axis, substantially confirming the results found by Wichmann, and recently by Prof. Pritchard.

An addition to the small list of stars which have been found to have a measurable parallax has been made by Dr. Ball. He finds that the star Groombridge 1618, which is remarkable for its large proper motion, has a parallax of about one-third of a second, so that it is to be considered one of the sun's nearest neighbours. Dr. Ball has also re-determined the parallax of the

double star 61 Cygni, his result being 0″·468, which agrees more nearly with Struve's value than with Bessel's.

The Cape catalogue of upwards of 12,000 stars is the outcome of Mr. Stone's labours during nine years, as Her Majesty's Astronomer at the Cape, and is the most important catalogue of stars which has yet been formed in the southern hemisphere. Another important contribution to stellar astronomy has been made by Prof. Newcomb, who has recently prepared a catalogue of the places of nearly 1100 standard stars compiled from the best authorities.

In connection with his photometric researches Prof. Pickering has discussed the causes of the variability of stars of short period. Taking the various hypotheses which have been proposed, he finds that for Algol and stars of that type the hypothesis of an eclipsing satellite or cloud of meteors revolving round the star is the only one which satisfies the observed phenomena. In the case of β Lyræ and similar variables the fluctuations of light would be explained as due to rotation round the axis, the two hemispheres being of unequal brightness and the form more or less elongated. Prof. Pickering has very carefully investigated the conditions in each individual case, and has brought together the most important facts bearing on the subject. It may be mentioned that on Prof. Pickering's initiative a committee of American astronomers has been formed to co-operate with European astronomers in selecting a series of stars to serve as standards of stellar magnitude.

The present year has been remarkable for the appearance of two bright comets simultaneously visible to the naked eye. The first comet was first seen in the southern hemisphere before its perihelion passage, and burst upon our view in its full splendour soon after perihelion. The most important point in connection with this comet was that photographs of its spectrum were obtained by several physicists, and in particular by Dr. Huggins, who found on his photographs two strong bright lines in the ultra-violet corresponding to a group in the spectra of compounds of carbon, and also a group of lines between G and h agreeing in position with another carbon band. The photographs also showed a continuous spectrum extending from F to some distance beyond H, on which the dark Fraunhofer lines were seen—an indication that part of the light from comets is reflected solar light.

In the visible portion the continuous spectrum was so bright when the comet was first seen after perihelion that it almost obliterated the ordinary cometary bands. These, however, became afterwards very conspicuous, and five bands were noted which were found to coincide sensibly with the carbon band as given by the flame of the Bunsen burner. On the brightest band, three bright lines corresponding to three lines in the carbon band were seen by several observers at Princeton, U.S. These observations show conclusively that the spectrum of this comet is identical with the first spectrum of carbon, and not with the second.

In the telescope this comet showed striking changes from day to day, and even, according to some observers, from hour to hour, and the head was remarkable for its unsymmetrical appearance. Another point of interest is that the orbit presents a remarkable resemblance to that of the great comet of 1807. As, however, the period of this latter was found by Bessel to be 1540 years, the question arises again, as in the case of the comets of 1843 and 1880, whether there are not two comets travelling along the same path.

The second bright comet was first discovered with the telescope, and gradually increased in brightness till it became visible to the naked eye, though by no means so interesting an object as the preceding comet. Besides these two bright comets, several telescopic comets have been discovered, raising the total for this year to eight. The last but one of these has proved to be a periodic comet, revolving in the short period of about eight years. It was discovered by an Englishman, Mr. Denning, being the first instance of such a discovery in this country for many years.

The Copley Medal has been awarded to Prof. Karl Adolph Wurtz, For. Mem. R.S. Prof. Wurtz has, for many years past, been one of the most distinguished leaders of the progress of chemistry, and is now the most eminent of active French chemists. The younger generation of French chemists were, for the most part, his pupils. His writings have been the medium by which most of the knowledge of the more modern theories of chemistry has been disseminated in France. His discoveries have been fruitful of the greatest results, not merely in the way of enriching the science with a knowledge of many previously unknown compounds and classes of compounds, but more especially in extending and improving our knowledge of the laws of chemical combination.

It was he who first discovered compound ammonias containing alcohol-radicals in the place of hydrogen—a family of compounds which has since acquired enormous development. It was he who first made those remarkable alcohols called glycols, and thus gave the key to the explanation of glycerine, erythrite, mannite, and the sugars. Many other discoveries of his might be quoted; but those who know the influence which these two have exercised on the progress of chemistry can feel no doubt that the author of them is deserving of the highest scientific honour.

One Royal Medal has been awarded to Mr. Francis Maitland Balfour, F.R.S. Mr. F. M. Balfour's investigations in embryology and comparative anatomy have placed him, thus early in life, in the front rank of original workers in these branches of science. His "Monograph upon the Development of Elasmobranch Fishes," published in 1878, embodies the results of several years' labour, by which quite a new light has been thrown upon the development of several important organs in the Vertebrata, and notably of the genito-urinary and nervous systems. More recently Mr. Balfour has published a most important work on "Comparative Embryology" in two large and fully illustrated volumes, which stands alone in biological literature, not only as an admirable and exhaustive summary of the present state of knowledge respecting the development of animals in general, but by reason of the vast amount and the varied character of the original researches which are incorporated in its pages.

A second Royal Medal has been awarded to the Rev. John Hewitt Jellett, F.R.S., Provost of Trinity College, Dublin. Dr. Jellett is the author of various papers on pure and applied mathematics; but the award is more directly connected with his invention of the analyser known by his name, and for the elaborate optico-chemical researches which he has made with it.

This analyser was introduced by its inventor into the instrument by which he has carried on his researches on the state of combination of mixed solutions, as evidenced by the changes in their power of rotating the plane of polarisation consequent upon a change in the proportion of the active ingredients which enter into the solution. This is a problem towards the solution of which ordinary chemical methods can contribute but little. A single instance will suffice to give an idea of the nature of the results. It is known that quinine forms with many acids two series of salts, one having twice the quantity of acid of the other for the same quantity of base, while with other acids only the less acid salt has been obtained; so that the ordinary chemical methods fail to give evidence of the existence of the more acid salt. Now, by examining the rotatory power of a solution of a given quantity of base with different doses of acid, Dr. Jellett was able to obtain evidence of the existence of two, and but two, salts of the base, no matter whether the acid were or were not one which yields two crystallisable salts. A slight deviation in the amount of rotation when the more acid salt began to be formed in tolerable quantity, from what it ought to have been, on the supposition that the whole of the acid introduced was combined with the quinine, was naturally attributed to a slight partition of the acid between the base and the solvent, regarded as a feeble base; but the smallness of the deviation indicated that a solution of the more acid salt mainly existed as such, and that it was not, as some had supposed, decomposed into free acid and the less acid salt.

The Davy Medal has been awarded to Prof. Adolf Baeyer. Prof. Baeyer was already known as the author of many masterly researches in organic chemistry, among which those on uric acid and on metallic acid deserve special mention, before his latest and most remarkable discovery. The process for the artificial formation and manufacture of indigo is the result of long-continued efforts, directed by singularly clear and accurate views of the order and mode of combination of its constituent elements, and of the conditions requisite for obtaining reactions indicated by theory.

The work of the Royal Commission on Accidents in Mines during the past year has been of such great interest, both from a scientific and from a practical point of view, that I venture to note at length some notes upon it, furnished to me by our Fellow, Mr. Warington Smyth, the Chairman.

A preliminary report was presented before the end of the

Session 1881, drawing attention, under the chief heads of the subject, to the facts and opinions elicited from the examination of a large number of competent witnesses.

Experimental inquiries, which will be the subject of a further report, have been instituted for the purposes of testing the various safety-lamps in use, as well as the numerous modifications recently proposed, and of determining the effect of coal-dust in causing or aggravating explosions. From time to time also experiments have been made with a view to substitute, in the breaking down of coal, some other means for the gunpowder shots which have so often, by their flame, caused the ignition of fire-damp.

The presence of a powerful "blower" of natural gas at the Garswood Hall Colliery, near Wigan, with the facilities offered by the proprietors, induced the Commission to erect suitable apparatus for a long series of these trials, and now that it appears desirable to compare the results with what may be obtained in another district and with a differently constituted fire-damp the whole of the apparatus is in course of erection at a colliery in the Rhondda Valley, where a very permanent "blower" offers similar advantages.

In the course of the lamp experiments it came out very clearly, in confirmation of statements before made, that the greatly augmented ventilation in our larger modern collieries has put an end to the fancied security of the simple Davy and Clanny lamps. Their use in fact, unless they be protected by some farther contrivance, is attended with the most imminent risk when the velocity of a current liable to be rendered explosive, exceeds six feet a second. A high degree of importance thus attaches to the comparative trials of lamps in which the flame is sufficiently shielded against the impinging stream of air, and those which have the property when immersed in an explosive mixture, of rapidly quenching both the flame of the wick and of the burning fire-damp.

The terrible disaster which occurred in September, 1880, at the Seaham Colliery, drew more anxious attention than ever to the question of the part played by coal-dust, and a special reference having been made by the Secretary of State for the Home Department to Prof. Abel, C.B., the experiments at Garswood Hall were largely extended. Some of the results were very remarkable; the proportion of fire-damp present with the air may be so small as to elude detection by the ordinary test of the carefully watched flame in the safety-lamp, and yet the presence of dust in suspension will cause rapid ignition, or even explosion, in a degree varying with the proportion of gas and the velocity of the current. Dust was employed from different parts of the works of several collieries where it was suspected that this agent had borne a serious part in intensifying and spreading explosions; and it was found that some of the varieties were far more sensitive than others. Certain kinds of dust, in themselves perfectly non-combustible, were similarly tested, and proved to have an analogous effect in promoting explosion, even when the percentage of gas was exceedingly small.

It is obvious from these facts that under certain conditions it is very important that a satisfactory indicator of minute proportions of fire-damp should be employed; and the further experiments proposed to be carried out by the Commission will include a particular inquiry into this subject.

The question of the feasibility of the introduction of the electric light into the workings of a colliery has been partially solved. The Stanton Coal and Iron Company were induced by the Commission to make a trial of Mr. Swan's lamps in their Pleasley Colliery, near Mansfield. Not only the inset and main road, but some of the "long-wall" faces of work, were brilliantly lighted in this manner. A second experiment of the same kind has been carried out at the Earnoch Colliery, near Hamilton.

The use and abuse of explosives in mining operations have in the last few years formed a subject of much inquiry, especially with reference to the firing of shots in coal-seams liable to be invaded by fire-damp. A return to mere wedging in all cases, as proposed by some officials, would be to ignore the advance of science as well as the necessities caused by competition; and the Commission hopes by further examination, and especially by practical trials, to contribute useful information to the solution of a difficult but important question.

Among the applications of scientific apparatus the employment of the ingenious protected lime-light lamp, and of the portable breathing arrangement of Mr. Fleuss, during the operations for re-opening of parts of the Seaham Colliery, deserves special notice.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Messrs. W. M. Hicks and W. W. R. Ball are appointed Moderators in the Mathematical Tripos for the year beginning next May. The Senior Wranglership will in future be adjudged in June.

The Examiners for the Natural Sciences Tripos in 1882 are Lord Rayleigh, Prof. W. J. Lewis, Prof. Morison Watson (Owens College), Drs. Gaskell, R. D. Roberts, and Vines, Mr. A. G. Vernon Harcourt (Oxford), and Prof A. M. Marshall (Owens College).

Mr. R. T. Glazebrook, Demonstrator of Experimental Physics, is approved as a Teacher of Physics, and Mr. A. S. Lea, Lecturer at Caius College, is approved as a Teacher of Physiology for the purpose of Medical Studies.

Clare College offers a Natural Science Scholarship, examination March 28; subjects: Chemistry, Chemical Physics, Botany, Geology. Candidates must give notice a fortnight previously to the tutor.

GLASGOW.—The matriculations for the present session number 2316, distributed among the various Faculties as follows, viz.:—In Arts 1327, in Medicine 624, in Law 211, in Theology 100, in Arts and Medicine 25, in Arts and Law 9, in Arts and Theology 20. The total number of matriculations last session was 2304, distributed as follows:—In Arts 1406, in Medicine 563, in Law 189, in Theology 85, in Arts and Medicine 29, in Arts and Law 18, in Arts and Theology, 14.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, October.—Experiments on the strength of wrought iron and steel at high temperatures, by Mr. Roelker.—On the proper method of expansion of steam and regulation of the engine, by Prof. Thurston.—On the last experiment with the Perkins machinery of the anthracite, by Ch. Eng. Isherwood.—Radio-dynamic facts, by Dr. Chase.—Universal energy of light, by the same.

Annalen der Physik und Chemie, No. 10.—Photometric researches on absorption of light in isotropic and anisotropic media, by C. Pulfrich.—On the vapour-tension of mixed liquids (continued), by D. Konowalow.—On the heat of formation of water, by A. Schuller.—On the heat-conductivity of gases and its connection with temperature, by L. Graetz.—Past observations on the expansion of water by heat, by P. Volkmann.—On the theoretical determination of vapour-pressure and volumes of vapour and liquid, by R. Clausius.—On heat-conduction in a system of cylinders, and on the experimental determination of the conductivity of water, by H. Lorberg.—On magnetic reaction, by F. Auerbach.—Application of the balance to the problem of gravitation, by Ph. v. Jolly.—On the spectra of hydrogen and acetylene, by A. Wüllner.—Some remarks on Herr Wesendonck's experiments on spectra of carbon compounds, by the same.—The minimum of deflection of a ray of light in a prism, by K. H. Schellbach.—Contribution to history of natural sciences among the Arabians, by E. Wiedemann.

La Natura, Nos. 21 and 22, November.—The Italian section at the Paris Electrical Exhibition, by R. Ferrini.—Thermal radiation of the sun, &c. (continued), by C. Cattaneo.—On the origin of electricity of storm-clouds and of the air, and on electricity in general, by F. G. Nachs.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 17.—"Researches on Chemical Equivalence." By Edmund J. Mills, D.Sc., F.R.S., and J. H. Bicket. Part IV.: Manganous and Nickelous Sulphates.

The authors have examined the precipitability and precipitation of manganous and nickelous sulphates, alone or commixed, by means of sodic carbonate. The chemical events they describe are represented in a series of four hyperbolas, whose equations are given in the memoir. They sum up their results as follows:—(1) Precipitability is a linear function of mass; (2) when the commixed sulphates are precipitated by sodic carbonate, equal weights of them are equally precipitable, the attraction of one of them for the reagent being the inverse of that of the other; (3) when the sulphates are separately precipitated by the same reagent, they are equally precipitable, and do

not exhibit the inverse function; (4) there is some evidence that the precipitabilities of the commixed and separate sulphates are mathematically related in a simple manner; (5) within moderate limits precipitation is not traceably affected by temperature.

"Researches on Chemical Equivalence." By Edmund J. Mills, D.Sc., F.R.S., and Bertram Hunt. Part V.: Nickelous and Cadmic Sulphates.

This series of experiments had for its object the comparison (as in Part IV.) of nickelous sulphate with a sulphate belonging to another group. The precipitability equations for the commixed salts are given; and it is shown that, according to these, nickelous and cadmic sulphates do not admit of comparison as equally precipitable substances. The authors say, in conclusion, "Our present inference with regard to the precipitability of nickelous-cadmic salt will lead (if confirmed by the action of reagents other than sodic carbonate) to the following important criterion:—*Two elements belong to the same group when*, in saline solutions of identical genus, *they may be equally precipitable.*

"Note on the reversal of the Spectrum of Cyanogen," by Professors Liveing and Dewar.

The authors have frequently noticed dark shaded bands which appeared to be the reversals of bands of oxides or chlorides of sundry metals, but only recently have they obtained photographs showing the reversal of the violet and ultra-violet flutings of cyanogen. The most complete reversal of these flutings were obtained by the use of a Siemens' machine in a crucible of magnesia fed with cyanide of titanium. No other cyanide has been found to produce this effect, but borate of ammonia has produced the reversal of the strongest group near L. In one case the reversal was produced by the bright background given by the expanded lines of magnesium when that metal was introduced. Probably the great stability of titanic cyanide and boron nitride has an influence on the result. The difficulty in reproducing the reversal at will is in securing an absorbing stratum of sufficiently high temperature, and at the same time a sufficiently bright background.

Geological Society, November 16.—R. Etheridge, F.R.S., president, in the chair.—Dr. T. Sterry Hunt, who was present as a guest, gave some account of the pre-Cambrian or Eozoic rocks of Europe as compared with those of North America. He had on several occasions studied them, both on the Continent and in the British Isles, especially with Dr. Hicks in Wales in 1878. In North America the recognised base is a highly granitoid gneiss, without observed limestones, which he has called the Ottawa gneiss, overlain, probably unconformably, by the Grenville series of Logan, consisting chiefly of granitoid gneisses, with crystalline limestones and quartzites. These two divisions make up the Laurentian of Canada, and correspond respectively to the Lewisian and the Dimetian of Hicks. Resting in discordance on the Laurentian, we find areas of the Norian or Labrador series (Upper Laurentian of Logan), chiefly made up of anortholite rocks, granitoid or gneissoid in texture, with some true gneisses. The Huronian is seen to rest unconformably on the Laurentian, fragments of which abound in the Huronian conglomerates. To the lower portion of the Huronian the speaker had formerly referred a great series of petrosilex or hälleflinta rocks, described as inchoate gneisses, passing into petrosilex-porphyries, occasionally interstratified with quartzites. This series, in many places wanting both in Europe and America, he is now satisfied forms an underlying unconformable group—the Arvonian of Hicks. Above the Huronian is the great Montalban series, consisting of grey tender gneisses and quartzose-schists, both abounding in muscovite, occasionally with hornblendic rocks. The Pebidian of Hicks includes both the Huronian and the Montalban, to which latter belong, according to the speaker, certain gneisses and mica-schists both in Scotland and in Ireland, as he had many years since pointed out. In some parts of North America he found the Montalban resting unconformably on Laurentian. Above the Montalban comes the Taconian (Lower Taconic of Emmons), a series of quartzites and soft micaceous schists, with dolomites and marbles. All these various series are older than the Lower Cambrian (Menevian) strata of North America; and it may be added that the Keweenian or great copper-bearing series of Lake Superior there occupies a position between the Montalban and the Cambrian. In the Alps the speaker recognises the Laurentian, Huronian, and Montalban, all of which he has lately seen in the Biellese, at the foot of Mont Viso, in Piedmont. The Huronian is the great *pietre verdi* group of the Italians, and much of what has been called altered Trias in this region is, in his opinion, probably Taconian. The Montalban forms the southern slope of Mont St. Gothard, and is the muscovite gneiss and mica-schist of the Saxon Erzgebirge. Here Dr. Credner and his assistants of the Geological Survey have described abundant conglomerates holding pebbles of Laurentian rocks imbedded in the Upper or Montalban gneiss. The pre-Cambrian age of this has been shown by Credner, who has proved by careful survey that the so-called younger or Palæozoic gneisses of Naumann are really but a continuous part of the older series. Late surveys also show that the crystalline rocks of the Taunus are really Eozoic, and not, as formerly maintained, Devonian in age. The speaker insisted upon the fact that where newer strata are in unconformable contact with older ones, the effect of lateral movements of compression, involving the two series, is generally to cause the newer and more yielding strata to dip towards and even beneath the edges of the older rock, a result due to folds, often with inversion, sometimes passing into faults. This phenomenon throws much light on the supposed recency of many crystalline schists.—The following communications were read:—Additional evidence on the land plants from the Pen-y-glog slate-quarry, near Corwen, by Henry Hicks, M.D., F.G.S.—Notes on *Prototaxites* and *Pachytheca* from the Denbighshire grits of Corwen, North Wales, by Principal Dawson, LL.D., F.R.S., F.G.S.

Zoological Society, November 29.—Dr. A. Günther, F.R.S., vice-president, in the chair.—A letter was read from Dr. A. Frenzel announcing his success in breeding parrots of the genus *Eclectus* in his aviary at Freiberg, in Saxony.—A communication was read from Dr. A. B. Meyer, C.M.Z.S, containing the description of a new species of *Eclectus* received from Timorlaut Island, which he proposed to name *Eclectus riedeli*.—Mr. R. Bowdler Sharpe read a note on the genera *Schœnicola* and *Catriscus*, and pointed out that these genera were identical, but that the South-African *S. apicalis* was specifically distinct from the Indian *S. platyura*.—Mr. G. A. Boulenger gave the description of a new species of *Anolis* from Yucatan, proposed to be called *Anolis beckeri*.—Mr. W. A. Forbes gave an account of the observations he had made on the temperature of the Indian Python (*Python molurus*) during her incubation in the Gardens of the Society in June and July last. The result arrived at was that in the present case there was a difference on the whole average of about 1°·4 Fahr. in favour of the female as compared with the non-incubating male when the temperature was taken on the surface, and of more than double that amount when the temperature was taken between the folds of the body.—Dr. Gwyn Jeffreys, F.R.S., F.Z.S., read the fourth of his series of papers on the Mollusca procured during the expeditions in H.M SS. *Lightning* and *Porcupine*, 1869 and 1870. This part concluded the Conchifera or Bivalves. Eighteen additional species, chiefly belonging to the genus *Neæra*, which is peculiar to deep water, were described. The geographical, hydrographical, and geological distribution, as well as the synonymy of all the species named in the paper, were treated of.—A communication was read from Dr. G. Hartlaub, describing the birds collected in Socotra and Southern Arabia by Dr. E. Riebeck. Amongst the Socotran birds was an example of a new species of finch of the genus *Rhynchostruthus*, which he proposed to call, after its discoverer, *R. riebecki*.

Royal Microscopical Society, November 9.—J. W. Stephenson, vice-president, in the chair.—The Rev. J. J. Halley, vice-president of the Microscopical Society of Victoria (one of the affiliated societies), attended the meeting, and gave an account of the progress of biology and microscopy in that colony.—Mr. Stephenson exhibited a slide of *Surirella gemma*, mounted in phosphorus, illustrating in a remarkable manner the advantage of mounting in media of high refractive index. Mr. Crisp, Mr. Crossley, and Mr. Watson exhibited various forms of microscopes and apparatus, and Mr. Mayall an Abbe apertometer of dense glass for measuring apertures up to 1·50 N.A., and a plate ruled by Fasoldt of New York, who claims to be able to rule lines up to 1,000,000 in the inch.—The deaths of M. Nachet, sen., of Paris, and Mr. C. A. Spencer of Geneva, N.Y., were announced.—Two papers were read by Dr. B. Wills Richardson on multiple staining of animal and vegetable tissues, and by Dr. L. G. Mills on diatoms from Peruvian guano; and Mr. T. Charters White exhibited and explained Goodwin's growing slide.—Eight new Fellows were elected.

Anthropological Institute, November 22.—Mr. Hyde Clarke, vice-president, in the chair.—The election of C.

Pfoundes was announced.—Mr. E. B. Tylor, F.R.S., read a paper on the Asiatic relations of Polynesian culture. The author called attention to some new evidence relating to the transmission of civilisation from the Indo-Chinese district of Asia through the Indian Archipelago to Melanesia and Polynesia. The drawings of wooden tombs in Borneo by Mr. Carl Bock show architectural design, apparently derived from the roof-projections of pagodas of Cochin China. The flute played with the nostrils may be traced from India (where it is said to have a ceremonial use to prevent defilement through touching a low-caste mouth), through South-east Asia into Borneo, to the Fiji Islands, and down to New Zealand. Among the traces of mythical ideas having spread from Asia into the South Sea Islands, Mr. Tylor mentioned the notion of seven or ten heavens and hells, apparently derived from the planetary spheres of the Pythagoreans. The Scandinavian myth of the fishing up of the Midgard serpent bears, as Prof. Bastian of Berlin has pointed out, a striking resemblance to Maui's fishing up the Island of New Zealand, and the Maori myth of the separation of heaven and earth has one of its best representatives among the Dayaks of Borneo. Leaving the question of race on one side, it is becoming more and more certain that much of the culture of the Polynesians came in some way from civilised nations of Asia.—The following papers were also read:—On Fijian riddles, by the Rev. Lorimer Fison.—On the stature of the inhabitants of Hungary, by Dr. J. Beddoe.—Notes on the affinity of the Melanesian, Malay, and Polynesian Languages, by the Rev. R. H. Codrington.—The discussion on Mr. Codrington's paper was adjourned to the next meeting, on December 13.

Institution of Civil Engineers, November 22.—Mr. Abernethy, F.R.S.E., president, in the chair.—The paper read was on the "Forces and Strains of Recoil considered with reference to the Elastic Field-Gun Carriage," by Mr. H. J. Butter.

Victoria (Philosophical) Institute, December 5.—The first meeting of the new session was held at the Institute's House, 7, Adelphi Terrace, on Monday evening, when a paper on Mr. Herbert Spencer's "Theory of the Will" was read.

Paris

Academy of Sciences, November 28.—M. Wurtz in the chair.—M. Faye presented the volume of the *Connaissance des Temps* for 1883.—The following papers were read:—New method of annulling the astronomical flexure of telescopes, by M. Villarceau. The simultaneous application to a well-made telescope of two weights in equilibrium, causes a variation of the astronomical flexure, proportional to their difference. Two iron rings, of fixed weight, are applied at distances from the axis of rotation, that are determined by formula.—On the isomeric states of haloid salts, by M. Berthelot.—Summary account of a zoological exploration in the Mediterranean with the Government vessel *Le Travailleur*, by M. Milne-Edwards. This expedition, organised by M. Milne-Edwards, left Rochefort on June 9, and returned August 19. Part of June and all July was devoted to the deeper parts of the Mediterranean. *Inter alia*, many Crustaceans, known only in the Atlantic before, were got in those depths; also remarkable species of Mollusca, Bryozoa, Cœlenterata, &c. The presence of the magnificent sea-star Brisinga was quite unexpected; several specimens were dredged between 550 and 2660 m. No Infusoria, Bacteria, or Microbes were found at great depths; Rhizopods were rare; at 2660 m. some small Actinophrys were obtained. In general the Mediterranean is not to be thought a distinct geological province; its inhabitants have probably come from the ocean, and their development and reproduction have been more active than in their place of origin. Some have been slightly modified. The more we get to know of oceanic productions off the coasts of Portugal, Spain, Morocco, and Senegal, the more do differences from Mediterranean animals disappear.—Fossil man of Lagoa Santa (Brazil), and his present descendants, by M. de Quatrefages. Several human crania were long ago found in a cavern near Lagoa Santa, by Dr. Lund, a Danish *savant*. His letter about them (1844) seems to have been forgotten. Most were sent to Copenhagen, but have not been described. One remaining in Brazil has been studied by Drs. Lacerda and Peixoto, who find the skull to have strong points of similarity to skulls of Botocudos of the present. This M. de Quatrefages confirms, and he further finds the type quite distinct from European fossil man, chiefly in the combinations of dolichocephaly and hypsistenocephaly. This Brazilian fossil man lived in the reindeer epoch. The type (with added ethnic elements not yet determined) is now met with in Ando-Peruvian populations, as well as in Brazil.—Admiral Paris presented a second series of his "Souvenirs de Marine Conservés," plates of old or disappearing types of vessels, comprising Danish ships previous to the siege of Copenhagen, Arab vessels, French fishing-boats, Turkish boats, &c.—Researches on a new property of the nervous system, by M. Brown-Séquard. Various parts of the nervous system may act suddenly, or very rapidly, in a purely dynamic way and without intervention of nutrition, on other parts of this system, so as to increase the power of action of those parts. Thus, *e.g.* by irritation of the skin the excitability of the phrenic nerve of the same side may be at once so increased that the minimum faradic current then required to set the nerve in action may be only one-sixth of that for the same nerve in a similar animal whose cutaneous nerves have not been irritated.—Observation of the new comet (g 1881) at Paris Observatory, by M. Bigourdan.—On algebraic equations of the form

$$\frac{A_0}{x - a_0} + \frac{A_1}{x - a_1} + \ldots + \frac{A_n}{x - a_n} = 0,$$

by M. Laguerre.—Distribution of energy by electricity, by M. Deprez.—Decomposition of vapour of water by electric *effluves*, by MM. Deherain and Maquenne. They show that certain electric discharges without sparks, and at a comparatively weak tension, will decompose water. They used sometimes MM. Thenard and Berthelot's well-known apparatus with double glass envelope, sometimes a tube traversed by a platinum wire, and having some tinfoil outside.—Contribution to the pathological anatomy of the spinal cord in poisoning with phosphorus, by M. Danillo. With phosphorus inflammator-irritation may be produced either in the grey substances alone, or both in that and in the white.—Reply to a note of M. Isambert on carbamate of ammonium, by MM. Engel and Moitessier.—On the post-embryonal development of Diptera, by M. Künckel.—On an electrolytic dosometer for measuring the intensity of the current during medical application of electricity, by M. Pulvermacher. The gases produced by decomposition of water are admitted into a chamber where they act on coloured water, forcing it up a tube to which a graduated scale is attached.—Mr. Axon communicated some facts about articulation by deaf mutes, confirming M. Hément's observations.—M. Bousset reported a curious case of double parturition by a cow.

Vienna

Imperial Institute of Geology, Nov. 22.—The following papers were read:—R. Hoernes, contributions to the knowledge of mid-Meiocene Trionyx species in Styria.—Standfest, on the Devonian formation in the environs of Gratz.—F. Kreutz, contributions to the explanation of the ozokerite and naphtha occurrence in Gallicia.—T. Woldrich, contributions to the knowledge of the fauna of Moravian caves.—E. Reyer, on the eruptive rocks of Toscana and Elba.

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THURSDAY, DECEMBER 15, 1881

CHARLES LYELL

Life, Letters, and Journals of Sir Charles Lyell, Bart., Author of the Principles of Geology, &c. Edited by his Sister-in-law, Mrs. Lyell. In two volumes. With Portrait. (London: John Murray, Albemarle Street, 1881.)

I.

"THE Principles of Geology" and "The Origin of Species" are the two books which have unquestionably exercised the most powerful influence upon the direction of scientific thought during the present century. The first of these works not only prepared the way for the second, but, as Darwin himself has told us, may actually be regarded as its progenitor, for it was the study of the "Principles" which induced the young naturalist to make his now famous "Voyage Round the World" and to collect those facts and observations out of which eventually grew the theory of Natural Selection. The wonderful revolution in thought which followed the appearance of the "Origin of Species" is still fresh in our minds, but those who could remember the effects produced by the publication of "The Principles of Geology," were wont to relate that fifty years ago scientific thought and speculation received an impetus no less powerful than that of which we have witnessed the results in our own time.

The story of the life of Sir Charles Lyell is the history of "The Principles of Geology," for all Lyell's other scientific writings are either expansions of portions of that great work, or are in some way or other supplementary to it. In the account of Lyell's earlier years we trace the birth and development of the ideas so clearly embodied in this famous book, while by the records of his later years we are reminded of the untiring energy with which he collected materials to expand and illustrate those ideas in the successive editions of the work.

The volumes before us enable us for the first time to trace this interesting story in all its details, and we cannot speak too highly of the skill and judgment with which the editor has arranged the materials at her command. The book consists essentially of Lyell's own journals and letters, a few short explanatory notes on the chief events of his life being interspersed in small type and inserted between brackets, together with a few foot-notes explaining allusions or giving details about persons mentioned in the letters.

Lyell, though born in Scotland, was by descent and education an Englishman. His earlier years were spent either in the New Forest and the towns in the south of England, where he went to school, or at the home at Kinnordy, in Forfarshire, where the family usually spent the autumn. In the south of England young Lyell, whose attention had been from boyhood directed to entomology, had the opportunity of studying the Tertiary deposits of the Hampshire basin; while in Forfarshire the draining of a small loch on his father's property and the excavation of the "marl" with which it had become filled, appear to have early directed his attention to some of the important questions connected with the mode of deposition of strata and the way in which organic remains become imbedded in them—questions afterwards treated by him with such skill and ingenuity in the "Principles." Lyell's two first papers, published in the *Transactions* of the Geological Society, relate to the strata of the Hampshire Basin and the formation of these marl-deposits in the lakes of Forfarshire.

At the age of seventeen Lyell went to Oxford, and there came under the influence of the brilliant and versatile, but eccentric, Buckland. But though impressed with the eloquence and filled with admiration at the energy of his teacher, there is evidence that at a very early date Lyell's mind underwent a revolt against the bold but shallow theorisings of the Oxford professor. When a few years later Buckland published his "Reliquiæ Diluvianæ," we find the pupil not only in open opposition to the master, but actually leading the attacks of the "Fluvialists" against the great stronghold of the "Diluvialists."

Upon leaving Oxford, Lyell was destined for the bar, but he, after reading law for a short time, was obliged to desist on account of the weakness of his eyesight. Under these circumstances he repaired to Paris, where he had the opportunity of constant intercourse with Cuvier, Brongniart, Humboldt, Constant Prévost, and the other brilliant scientific thinkers who were at that period assembled in the French capital. He at the same time studied with care the Tertiaries of the Paris basin, comparing the strata and their fossils with those with which he was already so familiar in Hampshire.

Lyell had now become so thoroughly engrossed in scientific work that all idea of advancement at the bar was abandoned by him, and after going two years upon the Western Circuit, he seems to have finally relinquished law for literature and science. He first began to write in the *Quarterly Review*, having formed a close friendship with Lockhart, then editor of that journal, and, after some papers upon educational questions, he in 1827 undertook a review of Scrope's "Geology and Extinct Volcanoes of Central France." It was in this work that Lyell first showed how entirely he had adopted the principles enunciated by Hutton and Playfair, and how far he was in advance of his most eminent contemporaries, Buckland and Sedgwick in England, and Cuvier and Humboldt on the Continent.

The five years from 1825 to 1830, during which Lyell was maturing his literary style by writing for the reviews and collecting the materials for his great work, may be regarded as the turning-point of his career, and the letters written by him at this period are of the greatest interest to the historians of science. We cannot forbear from making a few extracts illustrating the nature of his work and his views at this period. On June 22, 1826, he wrote to his friend Dr. Mantell—

"I must not sport radical, as I am become a Quarterly Reviewer. You will see my article just out on 'Scientific Institutions,' by which some of my friends here think I have carried the strong works of the enemy by storm. I am now far on with a second, and hope to get it out in less than three months. I mean to help myself out of Cuvier largely, for I must write what *will be read*" (vol. p. 164).

On March 2, 1827, he writes to the same correspondent as follows:—

H

"I devoured Lamarck *en voyage*, as you did Sismondi, and with equal pleasure. His theories delighted me more than any novel I ever read, and much in the same way, for they address themselves to the imagination, at least of geologists who know the mighty inferences which would be deducible were they established by observations. But though I admire even his flights, and feel none of the *odium theologicum* which some modern writers in this country have visited him with, I confess I read him rather as I hear an advocate on the wrong side, to know what can be made of the case in good hands. I am glad that he has been courageous enough and logical enough to admit that his argument, if pushed as far as it must go, if worth anything, would prove that man may have come from the Ourang-Outang. But after all, what changes species may really undergo! How impossible will it be to distinguish and lay down a line, beyond which some of the so-called extinct species have never passed into recent ones. That the earth is quite as old as he supposes, has long been my creed, and I will try before six months are over to convert the readers of the *Quarterly* to that heterodox opinion" (vol. i. p. 168).

His aspirations concerning his future at that time will be understood from the following extract from a letter written to his father in the same year :—

"I find my wants diminish monthly in proportion as I am more agreeably employed, and if with the willingness to work and industry which I now have, I had any chance of earning what I require by my own exertions, I should be without a care as far as I am myself concerned. But to be willing without avail to work hard, and almost for nothing, is now the fate of many hundreds of barristers, and many millions of our labouring classes, and we must congratulate ourselves at not being among the latter. I am quite clear, from all that I have yet seen of the world, that there is most real independence in that class of society who, possessing moderate means, are engaged in literary and scientific hobbies; and that in ascending from them upwards, the feeling of independence decreases pretty nearly in the same ratio as the fortunes increase. My eyes go on tolerably, and I feel my facility of composition increases, and hope to make friends among those that a literary reputation will procure me who may assist me" (vol. i. p. 171).

Under date of February 5, 1828, he wrote to Dr. Mantell explaining his plans for the work which he had been for some time contemplating :—

"I at first intended to write 'Conversations on Geology"; it is what no doubt the booksellers, and therefore the greatest number of readers, are desirous of. My reason for abandoning this form was simply this; that I found I should not do it at all, without taking more pains than such a form would do justice to. Besides, I felt that in a subject where so much is to be reformed and struck out anew, and where one obtains new ideas and theories in the progress of one's task, where you have to controvert, and to invent an argumentation—work is required, and one like the 'Conversations on Chemistry' and others would not do. It should hardly be between the teacher and the scholar perhaps, but a dialogue like Berkeley's Alciphron, between equals. But finally I thought that when I had made up my own mind and opinions in producing another kind of book, I might then construct conversations from it. In the meantime there is a cry among the publishers for an elementary work, and I much wish you would supply it. Anything from you would be useful, for what they have now is positively bad, for such is Jamieson's 'Cuvier'" (vol. i. p. 177).

In attempting to free geological science from the trammels with which it had become involved by the efforts of well-intentioned but mischievous works, like the "Vindiciæ Geologicæ" and the "Reliquiæ Diluvianæ," Lyell undertook no light or easy task. His letters to Scrope, who had been requested by Lockhart to review the "Principles" in the pages of the *Quarterly*, show very clearly how sensible Lyell was of the difficulties by which he was beset through the nervous susceptibilities of orthodoxy. The fact that the works of Hutton and Playfair had long ago been placed in a social "Index Expurgatorius," and that Scrope's clear and admirable exposition of the Huttonian doctrines, published in his "Considerations on Volcanoes" in 1825, had altogether failed to revive interest in the ostracised works, was full of warning to Lyell. We find him writing to Scrope, while the first volume of the "Principles" was going through the press, in the following terms :—

"I was afraid to point the moral, as much as you can do in the *Q. R.*, about Moses. Perhaps I should have been tenderer about the Koran. Don't meddle much with that, if at all.

"If we don't irritate, which I fear that we may (though mere history), we shall carry all with us. If you don't triumph over them, but compliment the liberality and candour of the present age, the bishops and enlightened saints will join us in despising both the ancient and modern physico-theologians. It is just the time to strike, so rejoice that, sinner as you are, the *Q. R.* is open to you.

"If I have said more than some will like, yet I give you my word that full *half* of my history and comments was cut out, and even many facts; because either I, or Stokes, or Broderip felt that it was anticipating twenty or thirty years of the march of honest feeling to declare it undisguisedly. Nor did I dare come down to modern offenders. They themselves will be ashamed of seeing how they will look by-and-by in the pages of history, if they ever get into it, which I doubt. You see that what between Steno, Hooke, Woodward, De Luc, and others, the modern deluge systems are all borrowed. Point out to the general reader that my floods, earthquakes, &c., are all very modern, also waste of cliffs; and that I request that people will multiply, by whatever time they think man has been on the earth, the sum of this modern observed change, and not form an opinion from what history has recorded. Fifty years from this, they will furnish facts for a better volume than mine. . . ."

"I conceived the idea five or six years ago, that if ever the Mosaic geology could be set down without giving offence, it would be in an historical sketch, and you must abstract mine, in order to have as little to say as possible yourself. Let them feel it, and point the moral" (vol. i. p. 271).

On two points, as has often been pointed out, Lyell may be held to have betrayed weakness in his reasoning in the "Principles." The first of these was that he appeared to accept in the most uncompromising manner the stringent Uniformitarian views of Hutton, leaving no place even for variations in the intensity of causes now operating. In taking this line he was doubtless influenced by fear of making any dangerous concessions to his adversaries the "Diluvialists." His real feelings on the subject may be gathered from a letter in which he replies to the remonstrances of Scrope upon the subject—

"All I ask is, that at any given period of the past don't stop inquiry when puzzled by refuge to a 'beginning,' which is all one with 'another state of nature' as it appears to me. But there is no harm in your attacking me, provided you point out that it is the proof I deny, not the probability of a beginning. Mark, too, my argument,

that we are called upon to say in each case, 'Which is now most probable, my ignorance of all possible effects of existing causes,' or that 'the beginning' is the cause of this puzzling phenomenon?" "It is not the beginning I look for but proofs of a *progressive* state of existence in the globe, the probability of which is *proved* by the analogy of changes in organic life" (vol. i. p. 270). See also upon the same subject his letter to Whewell in 1837 (vol. ii. p. 2).

The other question upon which Lyell's reasonings in his "Principles" betrayed weakness and inconsistency was that of the cause of the appearance from time to time of new species of plants and animals upon the earth. While stoutly maintaining the sufficiency of existing causes to account for the gradual disappearance of species by extinction, he felt himself compelled to invoke a creative power to introduce the new species as they were required. But, before we blame Lyell for this apparent weakness, we ought to remember that the work of Lamarck, the only serious attempt which had been at that time made to account for the origin of species, though brilliant and suggestive, was full of assumptions and fallacies that could not fail to betray themselves to Lyell's logical mind, and to militate against his acceptance of the theory. Lyell, moreover, saw only too clearly that the origin of man could not be treated of on different principles to that of other species of animals, and to have come into conflict with the prejudices of the day upon such a point as this, would have been to sacrifice all chance of a patient hearing for his arguments in favour of the "good cause" of which he felt himself to be the apostle. A very interesting letter written by him to Sir John Herschel in 1836, shows very clearly that Lyell had even at that early date thought deeply on the question of the origin of species by natural causes.

"In regard to the origination of new species, I am very glad to find that you think it probable that it may be carried on through the intervention of intermediate causes. I left this rather to be inferred, not thinking it worth while to offend a certain class of persons by embodying in words what would only be a speculation. But the German critics have attacked me vigorously, saying that by the impugning of the doctrine of spontaneous generation, and substituting nothing in its place, I have left them nothing but the direct and miraculous intervention of the First Cause, as often as a new species is introduced and hence I have overthrown my own doctrine of revolutions, carried on by a regular system of secondary causes. I have not wasted time in any controversies with them or others, except so far as modifying in new editions some opinions or expressions, and fortifying others, and by this means I have spared a great deal of ink-shed, and have upon the whole been very fairly treated by the critics. When I first came to the notion, which I never saw expressed elsewhere, though I have no doubt it had all been thought out before, of a succession of extinction of species, and creation of new ones, going on perpetually now, and through an indefinite period of the past, and to continue for ages to come, all in accommodation to the changes which must continue in the inanimate and habitable earth, the idea struck me as the grandest which I had ever conceived, so far as regards the attributes of the Presiding Mind. For one can in imagination summon before us a small part at least of the circumstances that must be contemplated and foreknown, before it can be decided what powers and qualities a new species must have in order to enable it to endure for a given time, and to play its part in due relation to all other beings destined to coexist with it, before it dies out. It might be necessary, perhaps, to be able to know the number by which each species would be represented in a given region 10,000 years hence, as much as for Babbage to find what would be the place of every wheel in his new calculating machine at each movement.

"It may be seen that unless some slight additional precaution be taken, the species about to be born would at a certain era be reduced to too low a number. There may be a thousand modes of insuring its duration beyond that time; one, for example, may be the rendering it more prolific, but this would perhaps make it press too hard upon other species at other times. Now it it be an insect it may be made in some of its transformations to resemble a dead stick, or a leaf, or a lichen, or a stone, so as to be somewhat less easily found by its enemies; or if this would make it too strong, an occasional variety of the species may have this advantage conferred upon it; or if this would be still too much, one sex of a certain variety. Probably there is scarcely a dash of colour on the wing or body of which the choice would be quite arbitrary, or which might not affect its duration for thousands of years. I have been told that the leaf-like expansion of the abdomen and thighs of a certain Brazilian Mantis turn from green to yellow as autumn advances, together with the leaves of the plants among which it seeks for its prey. Now if species come in in succession, such contrivances must sometimes be made, and such relations predetermined between species, as the Mantis, for example, and plants not then existing, but which it was foreseen would exist together with some particular climate at a given time. But I cannot do justice to this train of speculation in a letter, and will only say that it seems to me to offer a more beautiful subject for reasoning and reflecting on, than the notion of great batches of new species all coming in, and afterwards going out at once" (vol. i. pp. 467, 469).

It is probable that during later years Lyell receded somewhat from the position he was prepared to take up at the time when he wrote the above. The crudeness of speculation and ignorance of scientific facts which characterised the earlier editions of the "Vestiges of Creation" had in all likelihood not a little to do with this revulsion of thought, while the powerful influence of the leaders of biological thought, Edward Forbes and Louis Agassiz, always exercised in support of the idea of the permanency of species, doubtless had no little weight with Lyell, as it had with nearly all his contemporaries. How readily Lyell welcomed and embraced the views of Darwin as soon as they were published we all know, for he could not fail to see that by incorporation of the theory of natural selection into his work he was for the first time able to make it complete and consistent with itself. It is interesting to read in the volume before us the impressions made upon him by the first reading of the "Origin of Species" in 1859.

"My dear Darwin,—I have just finished your volume, and right glad I am that I did my best with Hooker to persuade you to publish it without waiting for a time which probably could never have arrived, though you lived to the age of a hundred, when you had prepared all your facts on which you ground so many grand generalisations.

"It is a splendid case of close reasoning and long-sustained argument throughout so many pages, the condensation immense, too great perhaps for the uninitiated, but an effective and important preliminary statement, which will admit, even before your detailed proofs appear, of some occasional useful exemplifications, such as your pigeons and cirripedes, of which you make such excellent use.

"I mean that when, as I fully expect, a new edition is soon called for, you may here and there insert an actual case, to relieve the vast number of abstract propositions. So far as I am concerned, I am so well prepared to take your statements of facts for granted, that I do not think the *pièces justificatives* when published will make much difference, and I have long seen most clearly that if any concession is made, all that you claim in your concluding pages will follow.

"It is this which has made me so long hesitate, always feeling that the case of Man and his Races and of other animals, and that of plants, is one and the same, and that if a *vera causa* be admitted for one instant, of a purely unknown and imaginary one, such as the word 'creation,' all the consequences must follow" (vol. ii. p. 325.

After the first publication of the "Principles" between the years 1830 and 1833, a great part of Lyell's time and thought was given up to revising, enlarging, and re-writing portions of his book during the twelve editions through which it passed. Although many valuable corrections were made in the original work, its scope and arguments being extended, and the whole fortified with a great wealth of new illustrations, it may well be doubted whether this continual re-editing of the book was not attended with some loss in the symmetry of its arrangement and its literary excellence. In a work relating to such a rapidly-advancing science as geology, this result, much as it is to be regretted, could scarcely be avoided; but many disciples of Lyell, while they refer to the last edition as a store-house of facts, will delight to renew their acquaintance with an old favourite by reading once more the easily flowing periods of the first edition.

We have dwelt at such length upon Lyell's relations to his great work, as illustrated in the interesting volumes before us, that we must defer to a second notice some of the other interesting topics which are suggested by their perusal.

JOHN W. JUDD

ORGANIC CHEMISTRY

Adolph Strecker's Short Text-book of Organic Chemistry. By Dr. Johannes Wislicenus, Professor of Chemistry in the University of Würzburg. Translated and edited by W. R. Hodgkinson and A. J. Greenaway. 8vo. (London: Kegan Paul, Trench and Co., 1881.)

THE new edition of Strecker's text-book by Prof. Wislicenus, published in 1874, is well known as giving a concise and comprehensive view of the state of organic chemistry at the time of its publication, and some useful additions, relating to recent discoveries, have been made by the English translators.

The classification of organic compounds in this, as in all recent works on organic chemistry, is based upon the hydrocarbons. All organic compounds of known constitution are divided into the two great groups, Fatty and Aromatic, and in each of these the saturated hydrocarbons—paraffins in the first, benzene and its homologues in the second,—are first described; next their mono-substitution derivatives: alcohols, ethers, amines, phosphines, &c.; then in succession the di-, tri-, tetra-, &c., derivatives. With regard to this matter Prof. Wislicenus says in his preface: "The most systematic arrangement would be found in the number of carbon-atoms in direct union. In each such group of equal carbon contents the paraffin would come first, next those derivatives in which only a single hydrogen-atom had been replaced, these being arranged according to the valency of the substituting element. Then would follow the di-substitution products. . . Next the tri-substituted paraffins. . . . This order of arrangement is very valuable for the study of organic chemistry, more so however for those moderately acquainted with the subject than for beginners. For the latter I think we cannot dispense with the study of homologous series, especially in the early part of a text-book. In this way alone can the clear differentiation of the various categories be made evident, depending, as they do, not so much on the accumulation of carbon-atoms, as on the nature and amount of the other elements in union." It is worth while to compare these remarks with those made by Roscoe and Schorlemmer in their lately-published "Treatise on Organic Chemistry," at p. 129 of which we read:—"Perhaps the most systematic mode of arrangement would be to commence each group (fatty and aromatic) with a discussion of the hydrocarbons, and then to follow on with a description of the series of substances obtained by the replacement of one, two, three, or more of the constituent atoms of hydrogen. Such a mode of classification, however, labours under the disadvantage that compounds which stand as a rule closely together, as, for example, the alcohols $CnH_{2n+2}O$ and the acids $C_nH_{2n}O_2$, are thus found widely separated, whilst other groups possessing but little analogy are brought into proximity. Hence it is desirable, alike for the sake of perspicuity as for the purpose of showing the genetic relationships between different bodies, to depart in many cases from such a systematic treatment, and arrange the compounds according as they are derived one from the other." It will be seen from these quotations that each author regards the arrangement adopted by the other as the most systematic, but prefers his own as best adapted to the requirements of the student.

The additions made to the work under consideration by the English editors belong chiefly to the aromatic group, but no mention is made of the recent investigations of Nevile and Winther, published last year in the Journal of the Chemical Society, on the Bromotoluenes, which are especially interesting on account of the light which they throw on the influence exerted by the groups or radicles which have replaced certain hydrogen-atoms in a benzene nucleus, on the position taken up by other radicles which take the place of the remaining atoms of hydrogen. In the series of paraffins there is an omission of the normal Heptane, lately discovered by Dr. Thorpe in the turpentine of *Pinus Sabiniana;* and amongst the nitroparaffins no notice is taken of the Nitrolic acids and Pseudonitroles. Under the organic compounds of boron we miss Dr. Frankland's Ammonioboric methide, $(CH_3)_3B{=}NH_3$ and Diboric ethopentethylate, $(C_2H_5O)_3B{=}B(C_2H_5)(OC_2H_5)_3$, in which boron figures as a pentad; and under guanidine there is no account of the Guanamines, $C_{n+2}H_{2n+3}N_5$, a series of bases discovered by Nencki in 1874 and 1876, and formed by the action of heat on the guanidine salts of the fatty acids.

The translation reads well, and, with the exception of a few instances of somewhat too close imitation of German forms, is expressed in good idiomatic English. There

are, however, certain irregularities of nomenclature which it may be worth while to notice, partly with the view to correction in future editions, partly because the greater number of them are not peculiar to this work, but are of very frequent occurrence in our chemical literature.

On p. 91 we read: "Carbon monoxide is the common radical of the carbonic acid derivatives, and as such is termed 'carboxyl'"; on the next page the compound CONH is called "carboxylimide"; and on p. 98 we read, "corresponding to carbo*x*yl is the radical CS, thiocarbo*n*yl." Here (and in the original) there is surely an inconsistency; if CS is thiocarbonyl, CO should certainly be called carbonyl; and such in fact is the name hitherto given to it by all writers, whereas carboxyl always denotes the group COOH. By a similar inconsistency the term *Ethyl-carbonic acid* is used on p. 353 as a synonym of propionic acid. Now most readers would probably understand by this term the compound $CO(OC_2H_5)(OH)$, *i.e.* carbonic acid having one of its hydrogen-atoms replaced by ethyl—an acid of which several salts are known—whereas propionic acid is $C_2H_5.COOH$, and its proper synonym is *ethyl-carboxylic acid.* The mistake here made arises from a too close imitation in sound of the German term "Carbonsäure," which, with the prefixes mono-, di-, tri-, was introduced by Kolbe to denote the number of carboxyl-groups, COOH, contained in an organic acid. In many instances however this term is correctly rendered; thus on pp. 557 and 561 we find the acids $C_6H_4(COOH)_2$ spoken of as *benzene-dicarboxylic acids*, though further on (p. 653) the same acids are called *phenylene-dicarbonic acids.* It seems indeed as if the two terminations were used indiscriminately.

Another irregularity of frequent occurrence in English nomenclature is the indiscriminate use of the terminations *in* and *ine.* Dr. Hofmann suggested some years ago that *ine* should be used exclusively for organic bases, and *in* for neutral bodies, such as glucosides, bitter principles, proteids, &c. This rule has been followed by some authors, and the writer of this review has taken some pains to recommend its general adoption; but the two terminations are still, by many writers, used without discrimination. As examples of this in the volume under consideration may be cited, on the one hand, gelatine, cholesterine, and on the other, chondrin, albumin, fibrin, dyslysin, &c. Now the use of special terminations for each group of compounds is very much to be desired; it is by no means an innovation, but, on the contrary, is as old as our systematic nomenclature itself; witness the well-known rule that the names of acids shall end in *ic* and *ous*, and those of the corresponding salts in *ate* and *ite.* To extend this regularity of termination to the names of all classes of compounds, especially in organic chemistry, is a main object of the rules lately issued by the Council of the Chemical Society to the Abstractors for that Society's journal, and its general adoption would certainly lead to a great improvement in our nomenclature in point of regularity.

The habit already noticed of too closely imitating foreign forms sometimes leads to awkwardness of expression in translating, as on p. 103, where it is said that "the paraffins burn easily when heated in an *oxygen-containing* atmosphere" (*in einer sauerstoffhaltenden Atmosphäre*); now it would have been quite as easy, and more in accordance with English usage, to say "in an atmosphere containing oxygen." Similar remarks may be made respecting the expression "carbon-free radical," which occurs on p. 565. It is worth some trouble to keep our language pure, and there is no more fruitful source of corruption in a language than the careless imitation of foreign words and idioms. And here I cannot avoid entering a protest against the use, in English speaking and writing, of the French words *mètre*, *décimètre*, &c., instead of their English equivalents, meter, decimeter, &c. *Meter* is a true English word, and is used both singly and in combination, as in the words barometer, thermometer, gasometer, &c., and there is therefore not the slightest occasion for interlarding our sentences with the French forms in question.

The translation affords also some instances of a very common error, viz. a confusion between the terms *substitution* and *replacement.* These words are indeed commonly regarded as synonymous, whereas they are really correlative, and the relation between them is this: *When* A *comes in and* B *goes out*, A *is substituted for* B, *and* B *is replaced, or displaced, by* A. The common error is to say "substituted," where the proper term would be "replaced." Examples both of the correct and incorrect use of these words may be found on pp. 100 and 101, *e.g.* "The hydrogen-atoms of the paraffins can be replaced . . . . by the halogen-atoms," &c.: this is correct; but a little lower down we find, "By *substitution* of only a single hydrogen-atom . . . ."; it should be by *replacement.* The same mistake occurs on the last line of p. 100; on the other hand the word "replaced" is correctly used in several places on p. 102. It would seem, therefore, that the translators regard the two words in question as synonymous.

Next with regard to notation: Many of the graphic formulæ throughout the volume are unnecessarily drawn out into long vertical columns, where they might with equal clearness have been printed horizontally; in one instance indeed seven formulæ fill up a whole page. In this, however, the English editors have simply followed the practice of the original work; but this was printed in 1874, and since that time it has been found that chemical formulæ may for the most part be printed much more concisely without any sacrifice of clearness. The formula of arsenic trichlorodimethide, for example, which is printed in the form $As\begin{cases}CH_3\\CH_3\\Cl\\Cl\\Cl\end{cases}$, might perhaps have been condensed into $(CH_3)_2AsCl_3$, without doing any great violence to the views of the author.

A more important matter, however, relating to notation is the habitual omission—sanctioned indeed by prevailing usage—of brackets in formulæ, where they ought to be inserted. It is of course unnecessary to insist upon the difference between $2a + b$ and $2(a + b)$, with which every schoolboy becomes familiar at a very early stage of his mathematical studies; but unfortunately it has lately become the fashion to ignore this difference in chemical formulæ, and to represent, for example, two molecules of alcohol by $2C_2H_5.OH$ instead of the proper form, $2(C_2H_5.OH)$. Now the neglect of this difference is of

quite recent introduction; for in chemical books of older date it was always observed, in proof of which see Gmelin's "Handbuch der Chemie" throughout. Gmelin indeed, in the first volume of his great work (4te Auflage, 1843, p. 61, and English Edition, i. 61) lays down the law of the case as follows:—"A number placed before several symbols multiplies them all, *as far as the next* + *sign or comma;* or if it stands before a bracket, it multiplies all the symbols and numbers included within the brackets." This rule is consistently followed all through the "Handbuch," and, so far as I know, in most contemporary chemical writings; but lately it has fallen into disuse, and a numeral placed before a set of unbracketted symbols is supposed to multiply them all, whether separated by addition-signs (+ , .) or not. Now this last practice would be all very well if consistently followed out; but unfortunately it is not, and hence confusion arises. For example, the formula $2SO_3, H_2O$ is used, sometimes to signify $S_2O_7H_2$, that is to say, one molecule of pyrosulphuric acid, while at other times it is employed to denote $S_2H_8O_4$ or $2SO_4H_2$, *i.e.* two molecules of sulphuric acid, which latter, according to earlier usage, would have been represented by $2(SO_3, H_2O)$. Again, in the formulæ of basic salts we find such expressions as $3Fe_2O_3, SO_3$, and $2Fe_2O_3, 3SO_3$, &c., in which the co-efficient 3 or 2 is understood to multiply only the Fe_2O_3, without affecting the SO_3; these formulæ being in fact identical with $SO_3, 3Fe_2O_3$ and $3SO_3, 2Fe_2O_3$ respectively. Now it is easy to see that this varying practice in the use or omission of brackets must lead to confusion, and it is much to be desired that the rule which formerly prevailed should be restored to use.

In conclusion, I hope it will be understood that the preceding criticisms are offered solely with the view of promoting uniformity in our nomenclature and notation, and by no means in disparagement of the volume under review, which is in every way a useful and valuable addition to English chemical literature. H. WATTS

OUR BOOK SHELF

Inorganic Chemistry, Theoretical and Practical. An Elementary Text-Book. By William Jago, F.C.S., &c. (London: Longmans, Green, and Co., 1881.)

Practical Chemistry. Adapted to the First Stage of the Revised Syllabus of the Science and Art Department. By J. Howard, F.C.S., &c. (London and Glasgow: William Collins, Sons, and Co., Limited, 1881.)

THE first-named of these books is a really good text-book for laboratory use; the experiments are clearly described; most useful "laboratory hints" are given; conclusions are carefully drawn from the experimental data obtained. The methods for proving the definition of boiling point, for illustrating the manufacture of sulphuric acid, and for confirming quantitatively the equation $KClO_3 = O_3 + KCl$, are especially to be praised. The student who works through this book will have laid a good foundation on which he may afterwards build; only let him skip those parts which deal with "chemical philosophy." Why should he begin his chemical career by learning that "combining weight" is synonymous with "atomic weight" (p. 31)? Why should he trouble himself with committing to memory the "atomicity" of the most important elements as given on p. 27 of this book? Why should he draw from the statement of Avogadro's law the erroneous conclusion that "the molecules of all gases are of the same size"? Why should he deceive himself by fancying that the formula N—O—N (p. 143) gives him accurate and well-grounded information regarding the molecule of nitrous oxide? No good reason can be given for doing any of these things, therefore let the student use this book as a laboratory guide only, and he will doubtless find it a trustworthy guide.

Could Mr. Howard's chemical philosophy be separated from his directions for conducting experiments, his book might also be recommended to the student of practical chemistry.

Although this book deals with laboratory experiments, one is much tempted to think that the author does not really regard chemistry as an experimental science. He deals with the general principles of chemical science too much from a literary point of view. An instance of this method is found in the preface, where we are told that "in former editions . . . the notation of Dr. Frankland was alone used. . . . In the present edition, however, it has been thought advisable to give, in addition, the notation and formulæ used by Professors Roscoe, Williamson, Thorpe, and others." This sentence is decidedly humorous; it connects so closely phenomena which appear to the student of chemistry to have but little in common.

Authoritative statements from the text-books exert a great influence on the author of this book; witness a sentence on p. 62: "A molecule must have all its bonds engaged, that is, it cannot combine with any substance without altering the arrangement of the atoms. Hence, there must always be an even number of *bonds* in the molecule of any element or in any compound." Nitric oxide is of course formulated as N_2O_2; no hint is given that the molecular formula of this gas is NO.

The first few pages contain many excellent examples of the misuse of that much misused word "force."

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Primitive Traditions as to the Pleiades

MR. JUSTICE HALIBURTON'S letter of December 1 (vol. xxv. p. 100) will have been read by many as calling attention to a curious subject. As it refers especially to me, and indeed arises out of my remark on the story of the "Lost Pleiad" in Dawson's "Australian Aborigines" (NATURE, vol. xxiv. p. 530), I now write a few lines in reply. But it will not be possible to discuss properly Mr. Haliburton's ideas as to the Pleiades till he publishes them in full, with the evidence on which he grounds them. It must not be supposed that the subject has been unnoticed till now by anthropologists. That the Pleiades are an important constellation, by which seasons and years are regulated among tribes in distant parts of the world, that they are sometimes worshipped, and often festivals are held in connection with their rising, that their peculiar grouping has suggested such names as the "dancers," or "hen and chickens," and that numbers of myths have been made about them—all this has long been on record, though in a scattered way, and at any rate it is well known to students. Mr. Haliburton's letter shows that he has new information to add to the previous stock, and furthermore that he has formed a theory that the Pleiad beliefs go back to a marvellously remote period in the history of man, when these stars were, as he says, the "central sun" of the religions, calendars, myths, traditions, and symbolism of early ages. If the astronomical evidence is to support so vast a structure as this, it need hardly be said that it must go far beyond what Mr.

Haliburton mentions in his letter. But when his contemplated book is published, he may be sure of his facts being appreciated and his theories fairly dealt with. Though, as I have just said, this cannot be done here, I may be allowed one suggestion. Mr. Haliburton is good enough to speak of me as being a cautious person. May I in that capacity express a hope that verbal coincidences, when not close enough really to prove connection, may be kept out of an argument which ought to go on a more solid footing. Why should the name of the star *Alkyone* have anything to do with the name of *Alkinoos*, king of Corfu? They look indeed rather more alike in Mr. Haliburton's letter, where the latter name is misspelt with a *y*, but doubtless this is a slip of the writer or printer.

A word about my remarks on the Pleiades-myth which has led to this correspondence. The question is only a small one, belonging to comparative mythology, whether a particular Australian tale about the Pleiades, one of a dozen such known in that quarter of the world, is a genuine native myth or a spoilt version of a story borrowed from the white men. I doubted its being genuine, because it says that the lost one of the seven was the queen or chiefess. This is hardly according to nature, for we should expect the star supposed to have gone away to be one of the insignificant ones of the group, not such a bright one as a story-teller would call the queen. Of the many Englishmen who have heard of the "Lost Pleiad" it is curious how few know the probable explanation of the classic tale, as a nature-myth derived from the difficulty of making out more than six stars with the naked eye. It has been suggested by some that there may have been a loss of brilliancy in one of the smaller stars of the group since ancient times. If any of your astronomical readers think there is anything whatever in this supposition, it would be interesting to have their judgment on it.

EDWARD B. TYLOR

Fumifugium

IN justice to Evelyn it ought, I think, to be made known that Mr. Shaw Lefevre was entirely wrong in stating at the opening ceremony of the Smoke Abatement Exhibition that "Evelyn proposed as a remedy for the smoke of which he complained, that the use of coal should be prohibited in the City and neighbourhood of London." "Fumifugium" (which was printed in 1661, and not in 1644) is of course extremely rare, and even the editor of the reprint which was issued in 1772, and is now rare, calls the original "this very scarce tract," so that the way in which the blunder in question has been repeated, is perhaps not to be wondered at.

As a matter of fact Evelyn only mentions the idea of supplanting coal by wood to call it "madnesse," and he then goes on to say: "But the *Remedy*, which I would propose has nothing in it of this difficulty, requiring only the Removal of such *Trades* as are manifest *Nuisances* to the City, which I would have placed at further distances, especially such as in their Works and Fournaces use great quantities of *Sea-Coale*, the sole and only cause of those prodigious Clouds of *Smoake* which so universally and so fatally infest the *Aer*, and would in no city of *Europe* be permitted, where men had either respect to Health or Ornament," thus recognising the two points of view so well represented by the cooperation of the National Health and Kyrle Societies. "I propose, therefore," he continues, "that by an *Act* of this present *Parliament*, this infernal *Nuisance* be reformed; enjoyning that all those *Works* be removed five or six miles distant from *London*, below the River of *Thames*, &c., &c." Although this has been done to a considerable extent, we may, I think, on a foggy day, agree with Evelyn when he says that "the City of *London* resembles the face rather of *Mount Ætna*, the *Court of Vulcan*, *Stromboli*, or the suburbs of *Hell*, than an assembly of rational creatures and the imperial seat of our incomparable *Monarch*."

W. H. CORFIELD

Jamaica Petrel

THIS bird, known locally as the "Blue Mountain Duck" or "Booby Duck," appears in a carefully compiled list of the birds of Jamaica, by Prof. A. Newton and his brother, the Hon. Ed. Newton, Colonial Secretary of Jamaica, published in the "Jamaica Handbook, 1881, p. 117, as follows:—"PROCELLARIIDÆ—*Œstrelata jamaicensis*, Bancroft, Jamaica Petrel. *Procellaria jamaicensis*, Bancroft, *Zool. Journ.* v. p. 81; Blue Mountain Duck, Gosse, "Birds of Jamaica," p. 437 (Hill); *Pterodroma caribbæa*, Carte, *P.Z.S.* 1866, p. 93, Pl. x." During certain seasons of the year it is remarkable that this sea-bird should be found in holes under trees and in burrows on the Cinchona plantations and in the unfrequented woods of the Blue Mountain range, at elevations from 6000 feet to 7000 feet. The natural inference was that the birds make their nests on these places. But, although careful search has been made during the last two years, and a reward offered for nests, eggs, or any signs of nidification, nothing whatever has been found in that direction. It is therefore very probable that the birds use these holes and burrows simply as resting-places during the day, from whence they sally forth at night to their feeding-grounds at sea. The latter is distant only, as the crow flies, about twelve or fourteen miles. The birds are found in their burrows chiefly during the months of November, December, January, and March. Sometimes two lie in one hole, and dogs easily find them; but it has been noticed that the birds are always full grown, and with no apparent nest. I have been led to send you these remarks in the hope that possibly some of your readers with a wider knowledge of the habits of petrels might be able to give some clue as to the locality and general character of their nesting-places.

D. MORRIS

Botanical Department, Jamaica, November 14

Biology in Schools

MANY eminent biologists seem to think that there are insuperable difficulties in the way of sound biological instruction in public schools. Possibly my experience in this connection may be of interest. I began to teach biology some ten years ago. Two years' experience satisfied me "that the power of repeating a classification of animals with all the appropriate definitions has any thing to do with genuine knowledge is one of the commonest and most mischievous delusions of both students and their examiners." For the third year I prepared a series of laboratory notes sufficient for the dissection of a few plants and animals. Since the publication of Huxley and Martin's admirable text-book of biology we have used that as a laboratory guide. Through the liberality of the School Board we are provided with eight of Beck's students' microscopes. We begin with the study of the torula; we then take in succession the following organisms:—Protococcus, amœba, bacteria, mould, stone-wort, ferns, flowering plants, infusorian fresh-water polyp, clam lobster, and frog. We devote to laboratory work one hour daily for seven months. At the end of the course come morphological and physiological generalisations. Our classes number about eighty, and are divided into working sections of sixteen each. The average age of the students is sixteen years, rather more than half of them being girls. I have found the students eager and enthusiastic, and a large majority of them regret the untimely end of their study of biology. To enter college a lad needs between four and five years' work in Latin, and, if a scientific student, about five weeks in botany. Most of our high schools accept this estimate of the value of a scientific training, and only do the little that is necessary for the pass examination.

GEO. W. PECKHAM

Biological Laboratory, Milwaukee High School, Milwaukee, Wisconsin

A Natural Ant Trap

LAST June I was staying at Husum, in the Lærdal Valley, Norway, and observed on the almost precipitous sides of the valley facing the south, immediately behind the station-house, a considerable number of the red German catchfly (*Lychnis viscaria*). The plants were growing luxuriantly at an altitude of some 1000 feet above the bed of the river, and were just then showing a gorgeous array of blossoms. On plucking some of the flowers I became aware of a most unpleasant stickiness around the stems; in some instances the glutinous secretion being powerful enough to support the whole weight of the stem when I inverted and opened my hand. Thereupon I carefully examined more than a hundred plants, and was somewhat surprised at finding, on quite 95 per cent., either the dead bodies of a large species of ant, or individuals in all stages of dying. Some flowering stems had only one dead or dying ant upon each; others had two; others three; whilst others again had as many as seven or eight. Some ants had, as it were, simply lain down in the glutinous matter and succumbed without further struggling. The heads of others, firmly imbedded in the treacherous stuff,

with the rest of the body stiffened and suspended in mid-air, testified to violent and prolonged resistance. Some ants again had the body arched up, as if to avoid contact with the stem, and the legs only were fatally caught.

As is well known, the glutinous or sticky tracts lie around the stem directly beneath the nodes, and are about half an inch or more in depth. These glutinous zones are absent from the nodes, which are lower down on the stalk. But a darkening of the colour, just similar to what one sees below the sticky nodes, suggests the probability of these non-sticky nodes having been sticky at some former time.

I can find no reference in the ordinary books to the fact that ants visit, and die upon, this plant. In Smith's "English Botany," 1800, however, occurs the following remarkable account of *Lychnis viscaria*:—"Stem straight, about a foot high, simple, angular, leafy, dark brown, and clammy under each joint, by which insects are plentifully caught, as in several other plants of the pink or campion tribe, for what purpose no one has yet ascertained; probably their decaying bodies form an air which is salutary to vegetable life." As I do not quite understand the author's meaning in the latter part of his remarks I naturally forbear criticising the statement, and mention it here merely to show the opinion of a botanist on the subject eighty-one years ago.

On each flowering stem there are from two to four sticky nodes. I found that the majority of the deaths had occurred in the first zone of stickiness; fewer in the second, and still fewer at the higher nodes. Those ants therefore which gained the summit of their ambition would be pre-eminently strong and lusty, for to have arrived at the top of the plant among the flowers, they must have waded through morasses, each of which was sufficient to cause the death of many of their comrades. I found very few ants at the summit of the flowering stalks, and those that I did find there alive showed, from their want of vigour and restlessness, that they had been severely tried by the ordeals through which they had passed. The plant was growing in very rocky soil, each specimen quite isolated from any surrounding vegetation; so that I am satisfied that no ants, on the plants I examined, could have gained the summits by adventitious aids.

Time and the want of proper apparatus prevented my making some experiments I wished to have tried, and as I do not know when again I shall be able to pursue this most interesting investigation, your kind insertion of this may perhaps induce some of your readers to pursue the subject further. These are amongst the questions which have occurred to me:—(1) Is there any attraction in the glutinous secretion, or does the attraction lie in the flowers? I saw no ant-hills or nests anywhere in the neighbourhood of the flowers, and my impression at the time was that the ants had come a long distance. I scrutinisingly examined the ground, and, to my astonishment, found that almost the only ants on the spot were upon the plants. (2) How is it, if these sticky zones are simply to prevent ants and other small walking animals from getting to the flowers, that they do not occur at the lower part of the stem as well as higher up? (3) What injury, if any, do ants cause to this plant? (4) Is it likely that the plant derives direct benefit from the deaths that take place upon it? Is there, in short, any digestive action in the glutinous secretion, and any absorptive power in those portions of the stem where it is found?

I brought home some specimens showing the dead bodies of ants stuck to the flower stalks, and these were exhibited at the last meeting of the Linnean Society. I shall be happy to show them to any who are interested in the subject. J. HARRIS STONE

11, Sheffield Gardens, Kensington, December 2

Solar, Gas-Flame, and Electric-Light Spectra

IN answer to Mr. J. Hopkins Walters' inquiry contained in NATURE, vol. xxv. p. 103, the spectroscope declares that all these three spectra have for their base a continuous strip or band of light; in the case of gas-flame (the bright part) crossed by the sodium lines only; in that of the sun by the well-known Fraunhofer dark lines; and of the electric (arc) light by the bright lines of carbon. The illuminating power of each of these sources of light is thus shown to be due to the incandescence of their several solid and gaseous constituents, concerning which a volume might be written. The relative effect of the sun's bright golden glare, the gas-flame's duller yellow tint, and the electric-light's moon-like whiteness, on the optic nerve; have not, as far as I am aware, been yet made the subject of special research. Popular opinion assigns injurious results to the whiter light. Mr. Walters will find in "Photographed Spectra," on Pl. xv., Fig. 4, and the extra plate, the solar spectrum, and on Pl. v., Figs. 3 and 4, the spectrum of the electric arc between carbon points specially prepared to insure purity. In Dr. Marshall Watt's "Index of Spectra" the spectrum of the blue base of candle-flame is represented by the graphical diagram and description, Carbon I. The illuminating portion of a gas-flame presents in the spectroscope the appearance of a dull sun spectrum without the dark lines. J. RAND CAPRON

Guildown, December 3

Tele-dynamics and the Accumulation of Energy—their Application to the Channel Tunnel

A REMARKABLE opportunity is now presented to electrical and mechanical engineers of applying to eminent practical service the recent discoveries and advances made in relation to the accumulation and transmission of energy in the form of electricity. I allude to the construction and working of the Channel Tunnel Railway. Of course the direct application of steam-power to the work of boring is out of the question. The power employed in boring Mont Cenis and St. Gothard was transmitted by compressed air through metal tubes, but this is a very costly, wasteful, and in some respects inconvenient process; and this cost and waste increases in a very high ratio to the distance of transmission. Since those works were executed an immense advance has been made in the practice of transmitting energy by electric current, and particularly in storing that energy; and I predict that if the tunnel is ever completed (which I do not doubt) it will be by means of electrical agency. An eminent civil engineer, who had invented a boring-machine which he considered of great promise for that work, told me more than a year ago that Dr. Siemens assured him that he would undertake to transmit 50 per cent. of the initial power by electric current half way through the tunnel; and by this time he would most probably give a much larger percentage. An eminent French authority promises from sixteen to twenty horse-power by a single current over a distance of from ten to fifty kilometres. If these statements are founded on fact your readers will at once realise the applicability and potency of the agent. Then there must of necessity be an immense quantity of material to be carried to and fro. The electrical railways of Berlin, Brussels, and Paris have left no question open as to the easiest and most economical means of propelling the trollies; and by using several conductors as many trolly trains in succession could be run as there would be conductors. It would be premature to discuss now the subject of working this railway, but it is certain that electricity will be the agent, and there is very little doubt that the twenty miles of level tunnel way will be worked by energy generated and stored by the train itself in its descent from the land level to the tunnel level. An examination of this question in detail would be incompatible with your space and purpose. I will simply say that a train of 100 tons descending a gradient of 1 in 100 for five miles would start with a potential force of nearly 60,000,000 foot pounds, a very small portion of which would be expended in useful work. Let the surplus of this be applied not to destroying the rails by brakes and conversion into useless heat, but by revolving generators and storing the product to be used in again turning the generators (now motors) for propelling the train. I do not say that the train could be lifted up the five miles at the other end by this stored energy: the engineers may be intrusted with that duty. E. WALKER

Tottenham

JOHNSTON LAVIS.—Your paper wants beginning and title. Please send.

DANTE AND THE SOUTHERN CROSS.—A correspondent inquires where Dante could have learned about the Southern Cross, to which there is evident allusion in the first canto of the "Purgatorio."

JAMAICA

OF all the West Indian Colonies appertaining to the British Crown, that of the Island of Jamaica can claim to be the largest in area, the most numerous in population, and the wealthiest in revenue. Within half a

century of being the oldest of the English possessions in the new world—Barbadoes was settled in 1605; Jamaica was capitulated in 1655—it has, though with many vicissitudes, been the most successful, and it has always shown strong signs of a healthy life, in that it has recovered promptly and well from its periods of misfortune. The extreme length of this fertile island is about 144 miles, while its greatest width is 49, and its least width 21 miles. Its surface is extremely mountainous, attaining a maximum in the Blue Mountain Peak of some 7360 feet. Of its superficial area of 4139 square miles only about 646 are flat, consisting of marl, alluvium, and swamps. It possesses numerous rivers and springs, and a fertile soil. Its total of population in 1861 was 441,264; in 1871, 506,154.

A Handbook to Jamaica, compiled from official and other records, has lately been published at the Government printing establishment at Kingston. It has been most judiciously edited by two members of the Jamaica Civil Service, and forms a volume of 450 pages, which deserves to be known to all interested in our colonies. Passing over the first two parts of the volume, which contain matter of chiefly local interest, the third part contains a chronological history of the island, with an account of its various parishes, its mountain ranges, lakes, and rivers, and an excellent sketch of its mineral resources, from which it would appear that the natural resources of the island have not as yet been satisfactorily explored. The fourth part is devoted to the consideration of the meteorology and climate, and of the birds, fishes, and insects of the isle.

Mr. Maxwell Hall is to be congratulated, that, after some opposition and under great difficulties, he has succeeded in some measure in establishing a system of daily weather reports, which are sent daily to the local press for publication. As the result of the reduction of a series of observations on the rainfall in different stations, and extending over periods of from five to fifteen years, Mr. Hall has been able to make out a certain systematic distribution of the rainfall over the island. It would thus appear that, while the May and October rains are everywhere strongly marked, the northern part of the island has winter rains in November, December, and January, the southern part has summer rains in August and September; and it would appear from the tables given that each part is further divided by the amount of the rainfall. Thus the north-eastern has the greatest rainfall; the west central comes next; the northern division third, and the southern has the least annual rainfall. Some such distribution, Mr. Hall thinks, was also existing at the time Sir Hans Sloane wrote his "Natural History of Jamaica" (about 200 years ago), and although he sees in the records of Sloane a change in the rainfall, yet he believes this to be not a constant change, such as might indicate a continually diminishing rainfall, but a variable change, probably systematic and periodic. On the question of the influence of forests on the rainfall, he decides that woods and forests are chiefly beneficial in reducing the range of temperature, and in maintaining the moisture of the ground, thereby preserving a constant supply of water for the springs and rivers. It may be noted that the central and uncultivated parts of Jamaica are still densely wooded, thereby aiding the constant river supply. Jamaica has two rainy and two dry seasons. The rainy seasons are in May and in October, lasting about two months, the intervening periods being dry. The climate may generally be described as a sedative one.

The Catalogue of the Birds of Jamaica is compiled by the well-known ornithologists Alfred and Edward Newton, the latter Colonial Secretary. Forty-three birds are enumerated as presumably peculiar to the island, that is to say, not known to have been found elsewhere. The list of the fishes is large. The river chub (*Labrax mucronatus*) is described as a "surpassingly delicious fish." Though fish abound in the seas, and each district has a sea-frontage, yet the yearly importation of cured "fish stuffs" of different kinds amounts in value to 200,000*l.* a year. To help and remedy this state of things the Jamaica Institute has offered a series of prizes for preserved fish.

The fifth and sixth parts treat of the economic botany of the island. The Government Surveyor, in reporting on the timber supply, estimates that there are at present about 800,000 acres of timber-producing forest in the island; that out of this there might be cut each year—without permanent injury—400 feet to the acre, say 320,000,000 as an annual supply; of this large amount only some 3,500,000 a year are actually cut for building purposes. About 166,000*l.* worth of fine timber was exported in 1880, but a large quantity of lumber and shingles is imported. This state of things Mr. Harrison accounts for by the difficulty of getting the timber out of the mountain fastnesses where it grows. He does not seem to agree with Mr. Hall on the subject of the change in the rainfall, for he declares that he has ascertained beyond doubt that forests exercise a great influence on it, that where the forests have been destroyed the rainfall has diminished, and he alludes to springs becoming dried up, and rivers that have ceased to flow. A very interesting list of some fifty of the woods of Jamaica, their qualities and the uses they are generally put to, is appended to this report. The island would appear to be a paradise for the fern collector, over 450 species being enumerated. Within a radius of five miles, taking Morce's Gap as a centre, over 200 species are to be found. The orchids are not so numerous, only 135 being named.

Of the main crops of the island, sugar still heads the list, the value of that exported in 1880 being 768,792*l.* The value of the coffee raised in the island in the same year is calculated at 381,595*l.* The coffee of the Blue Mountains is celebrated for its superiority, but a good marketable article is grown throughout the island. In a most valuable report by Mr. Morris, the present Director of Public Gardens strongly urges the propagation of the Liberian coffee, which was introduced in 1874. From the fact that this coffee will grow on the plains, where the preliminary expenses in the acquisition and clearing of land are lower than on the hills, where labour, too, is cheaper and more abundant, and where the difficulties and expenses of labour would be avoided, Liberian coffee possesses advantages not only over the Arabian coffee, but over almost any cultivation requiring the same capital and attention. Among the minor crops, that of the fruit crop is steadily and remarkably increasing in value, from 10,000*l.* in 1834 to 51,000*l.* in 1880. Jamaica tobacco is finding its way into the market. In the German markets—considered the most important for leaf-tobacco—Jamaica tobacco is well thought of, and in price ranks next to Havanna leaf, and since 1879 the consumption of Jamaica cigars in England has spread in an extensive manner. The cocoanut export, from a value of 3,357*l.* in 1870, has risen to 20,525*l.* in 1880. Ginger, pimento, and cacao are all successfully grown. The introduction of cinchona cultivation into Jamaica through a liberal supply of seeds sent in 1861 by Sir W. J. Hooker, promises to be a great success. For the year 1879-80 the quantity of bark shipped was 27,399 lbs., which realised the net sum of 5146*l.* From an elaborate report by Mr. Morris we take the following:—The plantations are estimated to cover nearly 400 acres; owing, however, to the practice of wide planting, the actual area occupied by regularly-planted trees is probably only a half of this. The advantages of close planting are undoubted. The climate of Jamaica would seem to be peculiarly well adapted for the successful cultivation of one or other of the various species of cinchona, at all elevations, from about 2500 feet to the Blue Mountain Peak itself. Thus *Cinchona succirubra* flourishes in the parish of Manchester at an elevation of

2700 feet, with a rainfall of about 120 inches and a mean annual temperature of 70° Fahr. This is perhaps the lowest elevation for the more valuable cinchonas at the Government plantations; the same species flourishes at 5000 feet, with an annual rainfall of 136 inches and a mean annual temperature of 60° F. The trees at this elevation do not seed freely, and it may be taken as the highest at which it would be advisable to cultivate the red bark in Jamaica. The range of cultivation for the valuable crown bark (*Cinchona officinalis*) is between 4500 and 6300 feet of elevation. It may here be convenient to refer to the department—that of Public Gardens and Plantations—which was newly organised in 1879. This department has under its control the Botanic Gardens at Castleton and Bath, the Park at Kingston, the Cocoanut Plantation at Kingston Harbour, and the Hope and Cinchona Plantation. The staff is directed by Mr. Daniel Morris, M.A., who had been assistant at the Ceylon Botanic Gardens. To an island dependent as Jamaica is for its prosperity on the produce of its soil, the importance of such a department is undoubted, and we trust that the new director will receive all due encouragement in developing the botanical treasures of the place.

The concluding parts of this most interesting handbook are devoted to the political constitution and parochial boards of the island; to the details of the various departments and colleges; to the statistics of population, crime, &c.; to the laws of quarantine, &c.; together forming a most useful volume of reference. There seems little doubt that if the capabilities of Jamaica were better known, it would attract the attention of settlers. There are surely as great attractions in bark or coffee-growing as in wool-growing, and Jamaica is nearer to us than the Australian colonies, and, with due precautions, as healthy a climate to live in.

OUR WINTER REFUGES—THE SOUTH OF ENGLAND[1]

II.

As regards temperature and rainfall the South of England, from Dover to Portland, presents a unique and well-marked winter climate, quite distinct from that of any other tract of the British Islands. The tract in question embraces the comparatively narrow belt, varying in width from two to ten miles, stretching between these two places and backed on the north by the sheltering range of the South Downs.

The rainfall in the east of England, from the Humber to Ramsgate, varies in the average annual amounts from 22 to 25½ inches; but on reaching Dover it rapidly rises to 30 inches, and from this point westward to Portland the rainfall varies only from 28 to 30 inches, the amounts differing within these narrow limits according to the flatness or boldness of the coast, and the character of the country in the immediate neighbourhood. To the west of Portland, along the coast, the rainfall rises considerably, and after passing Prawle Point, more rapidly to 44 inches at Penzance. Further, on striking inland from the coast towards and up the slopes of the Downs, the annual amounts increase to about 34 or 36 inches, on the high grounds separating the valley of the Thames from the lands sloping south to the channel; and from this ridge northwards it gradually falls to about 25 inches round London. Thus the Downs, as regards the rainfall and the winds, have important bearings on the meteorology of the south of England.

Equally decided are the temperature characteristics which mark off, climatically, these districts of England from each other. We may accept January as fairly representing the temperature peculiarities of the winter months. In this month the mean temperature of the whole of the eastern slope of Great Britain, from Wick to Dover, varies only from about 37°·5 to 38°·5, the temperature of the coasts being a little higher than that of the interior. But on arriving at Dover we encounter a January mean temperature of 40°·0, and from this point westward there is a steady increase, first slow as far as Worthing, where the mean is 40°·4, and then more rapid to Bournemouth, where the mean is 41°·2. On advancing inland upon the Downs, temperature falls much more rapidly than what is due to mere height, and this fall is continued in proceeding northwards towards London, the mean of which is 2°·5 and 1°·5 lower than that of Bournemouth and Brighton respectively. West of Portland the increase of temperature is still more rapid, the mean being 42°·9 at Torquay, 44°·6 at Falmouth, and 46°·2 in the Scilly Isles, the last temperature being the mean of London in the beginning of April.

Hence if the invalid requires a winter climate characterised by the combined qualities of mildness and dryness, such a climate must be sought for on the shores of the Channel from Dover to Portland. In the south-west a much higher temperature may be had, but the climate is there damper, and raw weather is of much more frequent occurrence; and in the eastern counties the climate is as dry, or rather drier, but the temperature of the air is from 2°·0 to 3°·0 colder.

The south coast possesses another climatic advantage of no small importance. The prevailing winds in the south during the winter months are west-south-westerly, and thus the winds which blow over the Isle of Wight pass on in the direction of London. Now we have seen that in passing from the Isle of Wight to London the mean temperature gradually falls 3°·0—the depression being due to the more rapid rate at which the land, as compared with the sea, is cooled down by terrestrial radiation. From this steady and continued lowering of the temperature of the south-westerly winds as they advance inland from the coast, it follows that haze and cloud are formed with greater frequency and of greater denseness as the winds successively advance into the colder districts. Hence the skies of the south coast are clearer and brighter than in the valley of the Thames—a consideration of the highest climatic significance in the cure of many diseases.

The generally light and porous character of the soil and subsoil along the south coast is a strong recommendation in favour of the sanataria of that region; because, as it affords a ready escape for the rain, the roads are quickly dry, and out-door exercise may be safely indulged in shortly after the rain has ceased. The generally bold character of the coast and sloping character of the surface is also advantageous as offering facilities for carrying out an effective system of drainage.

We have referred to the Downs as affording more or less shelter to the south coast from northerly winds, and to the Undercliff as a protection to Ventnor from north-east, north, north-west, and west winds (NATURE, vol. xxv. p. 33). Indeed the chief source of the advantages possessed by one of these watering-places of the south over another is the degree of protection it holds out from the deleterious effects of the easterly and north-easterly winds, and in some degree also to its distance from those parts of the Continent from which the east wind blows. Of the strictly local peculiarities which give one place a decided preference over another is the extent to which the district is planted with well-grown trees, by which the force of the winds, particularly east winds, is broken up and dissipated. In this respect the firs which have been planted in and around Bournemouth strongly recommend this sanatarium to the invalid, since, if fair overhead, he can almost always take outdoor exercise along the walks and promenades which are so completely sheltered by these evergreens. Bournemouth has the additional advantage of being to some extent protected from the full violence

[1] Continued from p. 34.

of the south-west winds by the South Downs of Dorsetshire, and also, though in a less degree, from the east winds by the Isle of Wight.

Since the averages here used are all for the twenty-four years ending with 1880 for the temperature, and for the twenty-one years ending with 1880 for the rainfall, the figures for these two chief elements of climate are strictly comparable throughout. The result is that all strong statements sometimes made in favour of local climatologies, such as the rainfall of Ventnor being as small as that of London, entirely disappear. Such differences could easily be found by the results of different terms of years suited to the purpose, being selected for the particular places whose climatologies are compared. All such comparisons, however, are not merely worthless, they are misleading.

It is, however, now indubitably shown that the south coast of England, from Dover to Portland, enjoys the best winter climate anywhere to be found in the British Islands as respects the two important qualities of mildness and dryness combined, and it is highly probable that the climate of the same tract has clearer, brighter skies, and consequently more sunshine, than elsewhere in these islands. In view of the results of Buchan and Mitchell's investigation into the weather and health of London (NATURE, vol. xxiv. pp. 143 and 173) it is evident that it is to the South of England the invalid who suffers from bronchitis, pneumonia, or other throat diseases, must look for the climate best suited in the treatment of his case, and that it is to the same climate, owing to its clearer air, brighter skies, and more frequent sunshine, that those suffering from nervous and mental diseases should look as more likely to give them the relief they are in search of.

TORNADOES, WHIRLWINDS, WATERSPOUTS, AND HAILSTORMS

I.

WHILE identical with and resembling cyclones in not a few of their leading characteristics, tornadoes and whirlwinds are yet in several all-important respects widely and radically different. The largest tornadoes are of so small dimensions when compared with the smallest cyclones as to point to a difference so decided that admits of no shading of the one class of phenomena into the other. Again, cyclones occur at all hours of the day, whereas whirlwinds and tornadoes are all but restricted to the warmer hours of the day, and perhaps altogether to the time of the day when the sun is above the horizon. Further, and intimately connected with the above, cyclones take place under conditions which imply unequal densities at the same heights of the atmosphere, whether these be due to inequalities in the geographical distribution of temperature or humidity; but whirlwinds occur where the air is unusually warm or moist for the time, and where, consequently, temperature and humidity diminish with height at an abnormally rapid rate. To put it otherwise, cyclones are phenomena consequent on a disturbance of the equilibrium of the atmosphere considered horizontally, but tornadoes, on the other hand, have their origin in a vertical disturbance of atmospheric equilibrium.

Hence whirlwinds are of occasional occurrence nearly everywhere, penetrating into regions where cyclones are altogether unknown; and even tornadoes, which are the most violent and destructive manifestations of the whirlwind, are phenomena either of rare or of frequent occurrence in nearly all climates.

Among the most remarkable of the tornado-swept tracts of the globe are certain portions of the United States of America; and to the examination of these the Meteorological Service of the States has given special attention by a systematic, careful, and minute observation of their attendant phenomena and their destructive effects. The results of these inquiries have been for some years recorded with great, but by no means too great, fulness and elaborateness in the annual meteorological reports of the Chief Signal Officer. Much has been done of late years, as our readers are aware, by observation and discussions of observations, to throw light on these atmospheric meteors; and in this connection we have the greatest pleasure in referring to Prof. Ferrel's recently published "Cyclones, Tornadoes, and Waterspouts," Part II., the portion of which, bearing on tornadoes and whirlwinds, is the most successfully handled part of that very suggestive work, and indeed presents the best theory of whirlwinds yet propounded.

Tornadoes, whirlwinds, and waterspouts are essentially the same, differing from each other only in their dimensions, their intensity, or in the degree in which the moisture is condensed into visible vapour; while the extraordinary downfalls of hail or rain, constituting the hailstorm and rainstorm, are simply the manner and degree of the precipitation. In the waterspout the main features of whirlwinds are best seen, owing to the degree, more or less complete, in which the vapour has been condensed into visible cloud through the whole length of the meteor.

Figs. 1, 2, and 3 represent different forms of the waterspout. In Fig. 1 is seen the black cloud covering the sky, from which a projection is let down from the cloud in the form of an inverted cone as at A, which continues to increase and extend downwards. The surface of the sea at D immediately beneath is soon seen to be stirred, and quickly thrown into a state of violent agitation. At this stage the whirling movement which originated in the clouds has extended downwards to the sea, and is doubtless continuous throughout, though the portion of the whirling column from A downward is not yet present to the eye by the condensation into cloud of its contained moisture. The cone at A continues to lengthen downwards, and ultimately reaches to the earth's surface as shown at B and C, and by the waterspouts of Figs. 2 and 3. As the whirling movements of the aërial column of the waterspout become more intensely developed, the increasing rapidity of the gyrations brings about increased rarefaction of the air within, with the inevitable result of increased condensation into cloud downward. The protrusion from the clouds and extension toward the surface of the sea of the waterspout is thus not due to the descent of vapour from the clouds, but to the visible condensation of the vapour of the spirally ascending air-currents arising from an increasing rarefaction due to the accelerated rate of the gyrations, the condensation being similar to that of the cloud seen in exhausting an air-pump.

The onward progressive motion of tornadoes and whirlwinds varies greatly, and is probably in all cases that of the general movement of that portion of the earth's atmosphere in which they are embedded and form a part. Tornadoes sometimes rage with destructive violence on heights and hill tops, while intervening valleys remain untouched, thus showing that they occasionally occur at comparatively small elevations, but do not reach down to the surface of the earth. It also sometimes happens that the tornado in its onward course rises for a brief interval above the surface and again descends. As soon as the rapidity of the gyrations of the column become diminished, the rarefaction of the air of the column and the condensation of the vapour are correspondingly lessened, and thereafter the waterspout gradually breaks up and disappears.

Under each of the waterspouts in Figs. 1, 2, and 3 the surface of the sea is seen to be more or less heaped up as well as in violent commotion, indicating that atmospheric pressure immediately under the gyrating column is less than it is all round. On land, when a tornado passes directly over a closed building, many instances have occurred when the whole building, walls and roof, has

been thrown outward with great violence, the wreckage presenting the appearance of a sudden explosion, proving that the pressure outside the building was instantaneously and largely diminished, and the building wrecked by the expansion of the air within. It is in this way that the tornado works no inconsiderable part of its most dreadful havoc in the destruction of human life.

During the storm of 1703, the greatest recorded in British history, it was observed that the roofs of many houses on the lee side of the buildings were wrecked as if by an explosion within. The destruction in this case was caused by the extreme rarefaction produced on the lee side of buildings by the mere mechanical action through friction of the terrific wind which swept past them. The records of tornadoes abound in illustrations of houses and other structures thus reduced to hopeless wrecks.

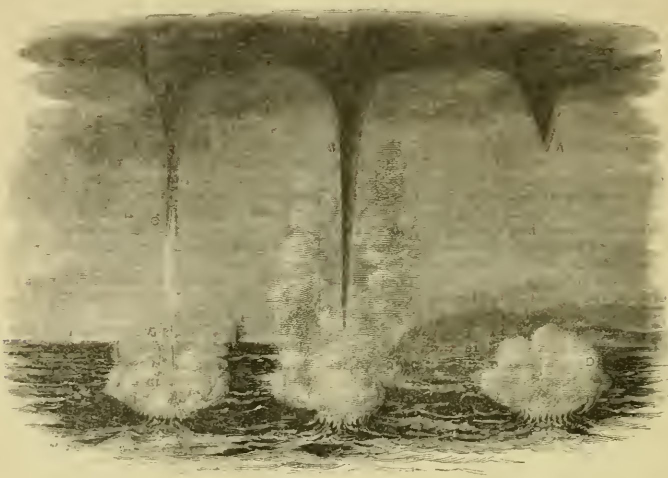

FIG. 1.

It is probable that the wind sometimes reaches a force in tornadoes exceeding what is ever reached in cyclones. During the tornado which occurred in Ohio on February 4, 1842, large buildings were lifted entire from their foundations, carried several rods through the air, and then dashed to pieces, some of the fragments being transported a distance of seven or eight miles; and large oaks nearly seven feet in girth were snapped across like reeds. This tornado sped on its course at the rate of thirty-four miles an hour, and at one place it did its fearful work in the brief space of a minute. During the tornado which swept over Mount Carmel, Illinois, June 4, 1877, the spire, vane, and gilded ball of the Methodist Church were carried fifteen miles to the north-eastward. On this incident Prof. Ferrel remarks that the ascending currents which could keep this structure suspended in the air for at least fifteen or twenty minutes must have had an enormous velocity.

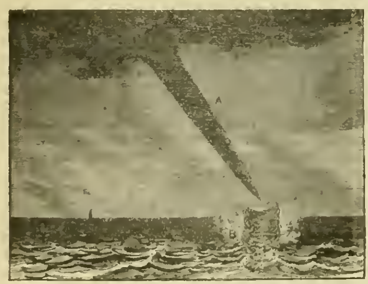

FIG. 2.

FIG. 3.

The usual position of the gyrating columns of whirlwinds is vertical, as seen in Fig. 1. Among other positions the column assumes a slanting direction as in Fig. 2, and a curved form as in Fig. 3. It is probable that to these latter forms many of those stationary or slowly moving dangerous squalls are to be referred that spring up with unexpected suddenness so frequently in such regions as the western lochs and islands of Scotland—

these sudden squalls which lash into a tempest of waves what is but a mere patch or narrow lane of sea, while all round remains like a sheet of glass, the squall being only the lowermost part of the gyrating column of a slanting whirlwind. Nothing is more surprising to the landsman who encounters one of these squalls for the first time than to see a mere bit of sea lashed into a tempest by say an east wind in which no sail can live, while but a short way to leeward other vessels are seen either under a good-going breeze or in calm water, altogether untouched by the tempest, which seems to blow directly to them, but which strangely never reaches them.

In examining cyclones, phenomena occasionally present themselves which strongly suggest the idea that they include within their circuit, as an independent meteor, the whirlwind or the tornado, the phenomena in question being most frequently met with in those cyclones which present, in close continuity, masses of air differing very widely from each other in temperature and humidity. Of such cyclones the great storm of October 14 last appears to be one. On that occasion the changes of temperature and humidity were sharp and sudden, particularly from the Grampians to the Cheviots, the great fall occurring when the wind changed to northward. As we have already stated (NATURE, vol. xxiv. p. 585), off the Berwickshire coast the darkness accompanying the changes of wind, temperature, and humidity was denser and more threatening than elsewhere, and almost simultaneously with the approach of these changes, a hurricane, or rather tornado, broke out with a devouring energy which bore everything before it. The tornado-character of the storm off Eyemouth is shown by the accounts of some of the survivors, who describe the wind as blowing straight down from the sky with an impetuosity so vehement and overmastering that the sea for some extent was beaten down flat into a stretch of seething foam, in which many boats sank as if driven down beneath the foam by the wind, while outside this tract the waves seemed to be driven up to a height absolutely appalling, which in their turn engulfed many of the boats yet remaining. Similar seas, with level wastes of seething foam, bounded immediately by waves of a height and threatening aspect never before witnessed, were encountered by several well-appointed steamers out in the middle of the North Sea during this storm, thus confirming the observations of the Eyemouth fishermen. These facts seem to point to one or perhaps more tornadoes of no inconsiderable dimensions, with slanting columns, the terrific force of the gyrations of whose lower extremities played no inconspicuous part in the devastation wrought during the continuance of this memorable storm.

(*To be continued.*)

SIR DAVID BREWSTER'S SCIENTIFIC WORK

BUT thirteen years ago there passed away from the roll of living scientific worthies one whose name will ever hold a high place for the variety and scope of the researches carried out with untiring zeal through a long and useful life. Since our last number the centenary of Sir David Brewster's birth has been commemorated in Edinburgh, and the occurrence forms a fitting opportunity to review briefly his multifarious work in the light of the science of to-day. Sir David Brewster was born in 1781. He must therefore have been twenty-five years of age at the date when his first published scientific memoir, entitled "Remarks on Achromatic Eyepieces" (published in *Nicholson's Journal*), saw the light. Until 1867 he continued actively to pursue scientific researches. Whilst his literary works are of themselves amply sufficient to cause the name of Brewster to be handed down to posterity, the long list of four hundred original memoirs which appears in his name in the Royal Society's Catalogue shows with what unremitting ardour the fire of discovery burned within his breast.

In the domain of Physical Optics Brewster was an eager and successful worker: and his industry was rewarded by a series of brilliant experimental discoveries. The genius of Young, the keen perception and quick acumen of Malus, and the trained intellect of Arago had been concentrated on this hitherto neglected department of science. But Brewster, who cannot be said to have possessed, either by birth or education, the powers of any of these investigators, discovered more than all of them put together, and by diligent observation unravelled complicated phenomena which baffled their powers.

In 1812, having heard of Malus's celebrated discovery of the polarisation of light by reflection, he took up the study of polarisation, and in the course of the next two years advanced our knowledge in various directions. He discovered the property of the agate to give a single polarised image; the polarisation of the rainbow; the polarisation tints in thin plates of crystal; the so-called depolarising power of mineral and other substances; and the partial polarisation produced by metals.

These discoveries he followed up immediately by several of equal interest. He observed the double system of elliptical rings of colour in topaz, and subsequently investigated the appearances presented by other crystals, both monaxial and biaxial in convergent polarised light. He not only discovered but determined the law of the partial polarisation effected by transmitting light obliquely through a bundle of thin plates of mica or glass. Meantime he was actively prosecuting literary work. His "New Philosophical Instruments," published in 1813, contained a great deal of matter new in the science of optics, the results of original research. Hitherto in tables of the refractive index of bodies diamond had stood at the head, and ice at the foot of the list. But Brewster showed that realgar and chromate of lead exceed the diamond in refractive power, whilst fluorspar, cyolite, and tabashear fall below ice both in refractive and in dispersive power.

During these and the subsequent years the disturbed relations between Great Britain and France prevented the workers in science on opposite sides of the Channel from learning what progress was being made, with the result that many of Brewster's discoveries were independently made by others. Thus Malus anticipated Brewster in the discovery of the "depolarising" effect of mica films, of the partial polarisation of metals, and of the polarisation effected by bundles of thin plates, though he missed the law of the last phenomenon. Arago also anticipated Brewster in finding the colours of thin crystal plates in polarised light. In 1814 and 1815 Brewster discovered a new relation of polarised light, namely, that existing between the ray and the state of mechanical strain of the body through which it passed. He observed that heated glass exhibited coloured tints in polarised light, and that Rupert's drops did the same. Subsequently he produced both double refraction and chromatic polarisation in soft and indurated jellies, in horn, and in a variety of animal and vegetable bodies, particularly in the crystalline lens of the eyes of animals, whose structure is thereby revealed. The most important of these early researches was undoubtedly the law connecting the angle of maximum polarisation by reflection with the refractive index of the body. The difficulty of establishing such a law was in Brewster's case enhanced by the circumstance that his mind was not a mathematical one. With a skill that rose superior to the defects of apparatus, and with an unflagging patience at which one can only marvel, he scrutinised with minute care every fragment of mineral in the cabinets of his scientific acquaintances. By this means he constructed tables of refractive and dispersive powers and of the polarising angles of the various reflecting surfaces. And from these two sets of data he brought out

the discovery of the tangent law now always identified with his name. But there were other occasions when some mere mathematician stepped in to take up the elaborate facts which Brewster had elaborated, and from them in a few minutes to deduce a law for which he took the credit of discovery. "It seems to us," writes Prof. Tait in an article which appeared in the *Scotsman* shortly after Brewster's decease, "that sufficient allowance has not been made for the natural irritation which such treatment was certain to cause, especially in a high-souled and single-minded man incapable of treating others as he felt himself treated. His biographer will have a painful, but a necessary and salutary, task to perform in gibbeting such thankless parasites. Many a much-praised scientific article—volume even—may be found where the facts are taken mainly from Brewster, though his name is barely mentioned. He was driven by such treatment into frequent disputes about priority, and in general he was successful, though often before the final settlement of the question the obnoxious paper had found its way to a non-scientific public, and even to foreign journals. It is always a difficult matter to determine what is the proper course for a philosopher under such circumstances. Few have the calmness to rely upon the almost invariably just decision of posterity; and most of those who do so go unrecognised to their graves."

In 1816 Brewster announced his discovery of the cause of the colours playing over the surface of mother-of-pearl, and of the possibility of transferring them to casts taken in wax, isinglass, and fusible metals. He also investigated the images and fringes of colour visible in some natural specimens of calc-spar, and turned his attention, though this time with only incomplete results, to the production of tints by multiple reflexions at the surfaces of polished metals. When in 1830 he returned to the subject, there resulted a remarkable memoir on Elliptical Polarisation, which appeared in the *Philosophical Transactions*. In 1817 he discovered the whole class of biaxial crystals, and triumphantly deduced the law of their action on light, thereby solving the difficulties which had perplexed Biot and Arago. He even sketched out a relation between the primitive forms of crystallisation of minerals and their optical behaviour.

His attention was next directed to the question of the absorption of light. In this department of science he made many observations. He was the first to observe in any systematic way the effects of absorption upon the prismatic spectrum. He reinvestigated the solar lines discovered by Wollaston and Fraunhofer, and observed even a larger number of them than the latter had detected. He made the important observation that many of these lines are due to absorption by the earth's atmosphere; and in one of the latest of his contributions to science—a joint paper by himself and Dr. J. Hall Gladstone, which appears in the *Philosophical Transactions* for 1860—he returned to the subject with unabated vigour and unsurpassed perspicacity of thought. He also discovered the power possessed by nitrous oxide gas to produce absorption lines, and he noted the great and extraordinary increase in their number and density when the gas is heated. "The power of heat alone to render a gas which is almost colourless as red as blood, without decomposing it, is in itself a most singular result; and my surprise was greatly increased when I afterwards succeeded in rendering the same pale nitrous gas so absolutely black by heat, that not a ray of the brightest summer sun was capable of penetrating it." Indeed he seemed to be here on the very verge of the discoveries on the spectroscopic significance of the width and frequency of the absorption lines which have been made by Mr. Lockyer, M. Janssen, and others during the present decade. In 1831 Brewster published his "New Analysis of Solar Light," the new analysis being nothing else than the operation of looking at the solar spectrum through coloured absorbent media. It was this series of experiments which led him to conceive the theory of the three primary colours which he so resolutely maintained against all opponents till his dying day. Through his red glass he could see light through a considerable range of the visible spectrum, and therefore, he concluded, there is some red in all parts, but with different degrees of brightness. The yellow and the blue were, he held, also distributed, each with a maximum of its own, throughout the range of the whole light. He believed that he had proved the conversion of blue rays into violet ones by viewing them through an absorbent medium. "We must remember," says Prof. Tait, by way of apology for the persistence with which Brewster clung to his pet theory, "that he trusted to an eyesight that had rarely deceived him—an eyesight once so perfect that he is one of but a very few who have *seen* the extraordinary ultra-red rays which he was the first to discover as visible light."

One of his researches connected the subject of absorption with his work on polarisation. He investigated the property known as *dichroism* possessed by a great number of coloured crystals, tourmaline, Brazilian topaz, and others, a property which has lately given rise to several important investigations by physicists in Germany and in England. He showed how the absorbed tints are altered by heating, and here he anticipated a point in the electromagnetic theory of light which was then of course quite undreamed of.

To enumerate the whole of Brewster's researches would occupy so many columns that only a few of the more prominent must now be adverted to. Optical illusions of sundry kinds, fluid cavities in crystals, polarisation of the sky, phosphorescence, fluorescence, photography, the optical properties of agate, opal, and labradorite, the magic mirror of Japan, and the theory of binocular vision, all claimed their notice and formed the bases of many careful researches. The experimental researches of Brewster in optics are in fact paralleled only by those of Brewster's great contemporary Faraday in electricity.

Brewster was the inventor of several well-known optical instruments. The *kaleidoscope*, which was brought out in 1816, created such a furore that 30,000 were sold in a few days. His *monochromatic* lamp appeared in 1823. In 1849-50 he brought out his lenticular *stereoscope* (an improvement upon Wheatstone's reflecting stereoscope of 1838), and a binocular camera, for use in producing stereoscopic pictures. Still more important, though far less widely known, was his discovery of the application of lenses and combinations of lenses to lighthouses. This was in 1812; in 1820 he was urging the adoption of his system on those in authority—two years before Fresnel, who usually gets the credit of this application, had begun his work.

His objections to the undulatory theory of light endured to the last, when he stood almost alone in his refusing explicit adherence to the theory. Trained himself in another school of thought, and accustomed through long years to the Newtonian theory, it is not remarkable that in the absence of mathematical predilections the mathematical intricacies of the fabric woven by Fresnel had little charm for him. And if we find it hard to realise the slowness of minds like Brewster's to receive the undulatory theory as an established truth, we may perhaps find no inapt parallelism in the repugnance felt even amongst some of the "crowned heads of science" at the present day towards entertaining the still more modern electromagnetic theory of light in which the undulatory theory is fast being swallowed up piecemeal.

Brewster's literary activity was simply extraordinary. He brought out the "Edinburgh Encyclopædia" between the years 1808 and 1830, writing many of the articles himself. To the seventh and eighth editions of the "Encyclopædia Britannica" he contributed the articles on Electricity, Magnetism, Microscope, Optics, Stereo-

scope, and Voltaic Electricity. No fewer than seventy-five articles in the *North British Review* are from his pen. From the year 1819 he was, along with Jameson, editor of the *Edinburgh Philosophical Journal*, in which so many of his researches saw the light. His "Letters on Natural Magic," his "More Worlds than One," his treatise on "Optics," his "Martyrs of Science," and his "Life of Sir Isaac Newton," all testify to an unremitting activity rarely equalled. He was made Principal of the University of St. Andrews in 1838, a post which he relinquished only in 1859 to succeed to the Principalship of the University of Edinburgh. As one of the founders of the British Association in 1831, no less than as a distinguished representative of science, he received the honour of knighthood.

A man who could unite so many varied qualifications in himself, who, besides adding so richly to the total of exact knowledge, could do so much to diffuse that knowledge to succeeding generations, who could write not only with the calm decision of a philosopher, but with the vivid imagination of a poet and even with the fervour of a preacher, must indeed be acknowledged to be a remarkable figure in the age in which he lived. His position in the physical sciences, standing as he did between the old generation of workers and the new, is not very easy to define. But his memory will doubtless descend to posterity in connection with numerous departments of the science of optics, in which his work remains to testify to his place amongst the men of science of whom Great Britain has just reason to be proud.

NOTES

THE Lord President of the Privy Council has appointed Prof. Archibald Geikie, F.R.S., to be Director-General of the Geological Surveys of the United Kingdom, and Director of the Museum of Economic Geology, Jermyn Street, in succession to Sir Andrew C. Ramsay, F.R.S., who retires from the public service towards the end of the present year.

MONDAY night was an enthusiastic Arctic night at the Geographical Society. The first paper was by Mr. C. R. Markham, on the important discoveries made by the *Rodgers* in and around Wrangel Land, and on the proposal that England should lend a hand to search for the missing *Jeannette*, and that a Government expedition should be sent out to look for Leigh Smith. Lieut. Hovgaard of the *Vega* also read an Arctic paper, detailing his plan for a *Jeannette* search from about Cape Chelyuskin as a basis; while an instructive paper was sent by the Dutch Commodore Janssens, on the ice-conditions in Barents Sea, and the probable position of Mr. Leigh Smith in the *Eira*. Of course Mr. Markham's energetic enthusiasm was infectious, and everybody seemed to agree that it would be disgraceful to England not to send out search expeditions. Sir George Nares and Sir Allan Young spoke, but it cannot be said that they threw much light on the problem; the good-natured Sir Allan took much trouble to say he knew nothing about these seas, and therefore he thought an expedition should be sent out for the *Eira*. Mr. Grant, the well-known Arctic photographer, told his experiences on the ice of the Barents with the Dutch and with Mr. Leigh Smith during the last four years, and he seems to think, what every one else thinks, and what is evident, that Mr. Leigh Smith is locked up in the ice somewhere. But all the speakers on Monday night evaded the main point, which was clearly stated in Mr. Eaton's letter in last week's NATURE (p. 123). Mr. Eaton declares that Mr. Smith went out with the deliberate intention of wintering, and that he has now provisions to last two years, Of course, in cases of doubt, it is well to take the worst possible view. But there seems to be a conflict of evidence. Mr. Eaton, than whom no one ought to know better, positively states that the *Eira* is provided as we have indicated; while on the other side there are vague and inconsistent statements. Were we convinced of the real danger of the *Eira's* situation, we should heartily support a relief expedition; but in this case there seems to be no doubt. The matter may be safely left in the hands of the Admiralty, who will doubtless look at the situation all round, and take care that they do not commit themselves, at the most, to more than a mere search, in conjunction, we should suggest, with relatives and friends. But on consideration of all the evidence, it may not be thought sufficient to warrant Government intervention. We were pleased to learn that the object of the Dutch in sending out expeditions year after year to these seas is to obtain a thorough knowledge of the movements of the ice before they venture to send out a fully-equipped expedition to force its way northwards; this is thoroughly scientific in its method.

A BALLOON accident, which we fear may turn out unfortunate, occurred in the South of England last Saturday. Capt. James Templer, Mr. Walter Powell, M.P., and Mr. Agg Gardner, ascended at Bath on Saturday at 1.55 p.m. for the purpose of taking the temperature of the air, and the amount of snow in the air, for the Meteorological Office. Capt. Templer, in a letter to Mr. R. H. Scott, describes what followed: "I cleared the snow clouds at 4000 feet altitude; the temperature of these clouds was 28°, and the wet-bulb thermometer read 26°. At 4200 feet we passed over Wells, the time being 2h. 50m. At this height I worked over Glastonbury; the temperature now rose to 41°, and the sky was perfectly clear. I passed then between Somerton and Langport, and I here found that I was in a N. ½ W. current. I asked Mr. Powell to send the balloon up to 6000 feet to ascertain the temperature of a small bank of cirrus. I found this temperature to be 31°, and then I asked him to place me at 2000 feet altitude, to regain the N. ½ W. current, and we then came in view of Crewkerne. I now kept at a low altitude until I reached Beaminster. Mr. Powell here observed that we were going at thirty miles an hour, and here we first heard the roar of the sea. The balloon suddenly rose to 4000 feet; at this time I said to Mr. Powell, "Go down to within 100 feet of the earth, and ascertain our exact position." We coasted along close to the ground until we reached Symondsbury. I here called to a man and asked him how far the distance was to Bridport, and he said about a mile. I asked Mr. Powell to prepare to 'take in,' our pace now increasing to thirty-five miles an hour. To avoid the little village of Neape Mr. Powell threw out some ballast. This took us to 1500 feet elevation, and we had still two miles to get in. I opened the valve and descended, about 150 yards short of the cliff. The balloon on touching the ground dragged a few feet, and I rolled out of the car with the valve line in my hand. This caused the balloon to ascend about 8 feet, when Mr. Gardner dropped off, and unfortunately broke his leg. I found that the rope was being pulled through my hands, and I called to Mr. Powell, who was standing in the car, to come down the line. He took hold of the line, and in a few more seconds the line was torn through my hands. The balloon rose rapidly. Mr. Powell waved his hands to me, and I took his compass bearings, and found that he was going in a S. ½ E. direction." Capt. Templer lost no time in getting into a steamer at Weymouth and searching the Channel in the most likely direction, but without result. Up to the present nothing has been heard of Mr. Powell, and the worst is to be feared. This accident is certainly to be regretted, more especially as the expedition was in the interests of science. Still in spite of the accident the Meteorological Council are to be congratulated upon the endeavour to get at the correct facts of the air.

IN the *Comptes Rendus* for December 5, 1881, p. 936, there appears a paper animadverting on the meteorological stations it has been proposed to establish in the neighbourhood of the

North Pole, which paper, according as it is looked at, is provocative either of amusement or amazement. It is amusing to read that it is all the way from the equator that these cirrus clouds travel, giving us Europeans, by systems of vorticose movements let down from their lofty heights, our cyclones, our rains, our thunderstorms, our hail, and even our snow; that, towards the elucidation of the great problems of the movements of the atmosphere in their bearings on climate and weather, the observations made forty years ago by Lottin, Martins, Bravais, &c., in the Arctic regions, are quite sufficient for the purpose. The additional data to be expected from the Arctic network of stations now proposed to be established at Bossekop, Jan Mayen, Navaja Zemlia, Spitzbergen, &c., being quite insignificant; and that the French meteorologists in agreeing to establish, as their contribution to this extensive research into the movements of the atmosphere, a station near Cape Horn, supposed, as assumed by M. Faye, that this station near the antarctic circle, would assist them in framing weather forecasts for France. It is amazing to see it quietly assumed that the fishermen and sailors on the French coasts have no practical, or at least personal interest in the storms which sweep across the British Islands and Scandinavia; and to read the explicit statement that in the interests of the seaports of France, and of science itself, what is above all things needed is the organising of a first-class meteorological station (*une grande station météorologique*) in the Azores. With regard to this, French sailors and fishermen may be thankful that other counsels rule the action of those who are entrusted with the preparation of weather forecasts for their country and with the investigation of those laws, a knowledge of which will enhance the value of this branch of practical meteorology.

In his inaugural address at the opening of the Session of the Sanitary Institute, Dr. Alfred Carpenter dwelt upon the necessity of such an organisation, as proved by the lamentable ignorance of the mere elements of sanitary science shown by many of the candidates for the diploma of the Institute, most of them already official guides of health and other bodies. It seems strange to be told by Dr. Carpenter that there is a feeling of antagonism to the Institute in the Social Science Association. The former is the practical outcome of the latter, and the Association ought therefore to rejoice that its teachings have borne such desirable fruit. The Institute is certainly doing much good, and there seems to be no doubt that by its action and by other means, a beginning has been made in this country of a thorough sanitary reform.

An instructive case of injury from lightning, on a gentleman's estate near Geneva, is recorded by M.. Colladon (*Arch. des Sciences*, September 15). The lightning first struck a tall poplar standing near an iron-wire fence; thence the fluid passed to an elm standing close to the fence on the other side, damaged three main branches of this, and wounded the trunk on the fence side, down to a point opposite the top wire of the fence. The course was then along this wire, but only, it appears, in one direction, viz. towards an iron gate a little way off, under which passed the pipe which supplied gas to the house. The wire, a double one, was fused in some parts. After damaging the gate the current found its way to the gaspipe (making a hole in the ground), and passed along this to the house, injuring no part of the pipe-system of that, but only a piece of ornamental rose-work containing iron wire in the ceiling of the drawing-room over the lustre. Thence it passed to earth by the iron pipes and wires on a balcony outside the room. Several bushes near the poplar and fence were affected (coloured brown), and the plate on the collar of a dog which was attached to a wire between two shrubs, and had been heard to howl at the time, had disappeared. The extended character of the discharge and the influence of wires seem to be salient points in this case. M. Colladon advises making the parts of telegraphic or telephonic wires that pass near a house double or triple the mean thickness, so as to diminish the chances of lateral discharge.

M. Plateau has studied the phenomena of the bursting of bubbles. When a bubble bursts it disappears almost instantaneously, leaving behind it a multitude of small liquid drops. The order of the phenomena is really as follows:—The bubble begins to burst at one point, the film rolling away in a circle around the opening, and its edge becoming a rapidly-enlarging liquid ring. This ring draws itself together into segmental portions, which ultimately become small spherules. At the same time the contraction of the rest of the bubble causes a rush of air through the aperture, and blows off the spherules into the air with a kind of small explosion. The phenomena are best observed by blowing a bubble of glyceric solution upon an iron wire ring, and then bursting it at the top by touching it with a needle whose point has been dipped in oil.

The conduct of competitive examinations in China seems to be farther from perfection than might be expected in the case of such an ancient institution. The *Peking Gazette* contains a memorial from one of the censors complaining that the matsheds which are erected at the entrance to the examination hall in the capital to issue tickets of admission to competitors are frequently overturned by the rush of applicants, that an unseemly crowding and snatching of tickets from the officials take place, and that candidates break the rule prohibiting them from leaving the compartments in which they are isolated during the examination. They are allowed, he says, to fetch their food themselves (examinations in China last from thirty-six hours to three days at a stretch) from the kitchens, and they meet and converse freely. Prepared essays, the memorialist fears, are passed in from outside during these hours by the student's friends. Again, when the lists of successful candidates are posted up, a tumultuous crowd assembles outside the gates; bands of the unsuccessful ones obstruct the progress of the chief examiner, employing threats and entreaties to prevail on him to alter the lists. The censor also protests against the length of time frequently taken before the results of an examination are known. The Chinese examiners, however, have an excuse for this which our own Civil Service Commissioners have not, viz., the number of students examined; at the triennial provincial examination held in Canton in 1879 there were 10,160 candidates for 82 degrees!

The death is announced of Mr. William Bramsen, a Danish gentleman whose acquirements in Japanese scholarship were extensive. During a residence of more than twelve years in Japan Mr. Bramsen devoted his leisure to a study of the language, chronology, and numismatics of the country. His principal work is "Japanese Chronology," published in 1880, the only complete treatise on the subject which has ever been written. In this laborious work Mr. Bramsen has given the exact day of the month and year corresponding to the Japanese dates for the past thousand years. He has further explained the complicated systems by which the Japanese and Chinese reckoned time, and has thrown out the suggestion that in the early periods of Japanese and Chinese history the year included the time between the equinoxes, and did not correspond to our year. This idea he has supported with much learning, and should it on further examination turn out to be correct, it will revolutionise our notions of the antiquity of the Chinese and Japanese peoples. During the past year Mr. Bramsen was engaged in producing in parts a beautiful work on Japanese numismatics. Only the first part, dealing with recent copper coins, had been published. A few weeks ago he read a paper on the subject before the Numismatic Society of London. His collection of Japanese coins was the most complete private collection in existence, and was, we believe, valued by himself at about 2000*l*. He

was not much past thirty at the time of his death. It was his intention to return to Japan so soon as he was called to the English bar. The main characteristics of his work—which was but an earnest of what might have been expected from him had he been spared—were thoroughness and care. It will be difficult to fill the important, and in some sense peculiar, position which he occupied in the field of Japanese scholarship. He was a member of the Royal Asiatic Society, and of numerous native and foreign societies in Japan.

THE Brighton Health Congress and Domestic and Scientific Exhibition are being held this week. The Exhibition, over which Lord Chichester presided, was opened on Monday. The Congress, over which Dr. Richardson, F.R.S., presided, was opened on Tuesday evening by the delivery of his inaugural address. Dr. Richardson spoke on the "Seed-time of Health," pointing out the perils that beset youth in the present condition of hygienic education, and empirical and unscientific practice. The sittings of the Congress will be continued until to-morrow. The Congress is composed of three sections. The first, presided over by Mr. Edwin Chadwick, C.B., relates to the Health of Towns; the second, presided over by Mr. J. R. Hollond, M.A., M.P., relates to Food; and the third, presided over by Dr. Alfred Carpenter, C.S.S., relates to Domestic Health. A large number of important papers are down for reading and discussion, including, amongst others, essays on slaughter-house reform, by Mr. H. T. Lester, B.A.; food-plant improvement, by Major Hallett; sanitation in decoration, by Mr. Robert Edis, F.S.A.; food preservation by cold, by Mr. T. B. Lightfoot; recreation spaces in large towns, by Dr. Fussell; bread reform, by Miss Yates; cheap food and longevity, by Dr. Drysdale; rational feeding, by Mr. Wynter Blyth; diet in public institutions, by Dr. Whittle; home sanitation, by Mr. H. H. Collins; a comparison of English and foreign watering places, by Mr. H. S. Mitchell, M.A.; health lessons in schools, by Mr. Charles Cassal, B.A.; clothing and health, by Mrs. E. M. King; and papers by Sir Antonio Brady, Dr. Browning, Edward Easton, C.E., Ellice Clarke, C.E., Messrs. Stephens, E. Bailey Denton, and others. Yesterday the Mayor and Mayoress held a reception in the Pavilion. To-day, Dr. Taaffe, Medical Officer of Health for Brighton, delivers a public lecture. On Saturday, excursions will be made to various places of interest in and about Brighton, and in the evening of Saturday, the proceedings of the Congress will be brought to a close by a lecture to the working classes from Mr. Brudenell Carter, F.R.C.S., on the subject of Eyesight. The Exhibition is on a most extensive scale, including objects relating to food; domestic, labour-saving, and educational appliances; house sanitation; industrial dwellings; lighting, electrical and kindred inventions; decorative art, such as photography, painting on china; horology; and a very extensive loan collection of great value from the South Kensington Department.

AT the meeting of the Sanitary Institute on December 7, Dr. Alfred Carpenter in the chair, the adjudicator, Dr. W. Farr, F.R.S., and Dr. Richardson, F.R.S., reported that the Wyatt-Edgell prize of 200*l.* for an essay on the Range of Hereditary Tendencies in Health and Disease was awarded by them to the essay bearing the motto "The subtlety of nature far exceeds the subtlety of reason." On the sealed envelope accompanying the essay being opened the chairman announced the author to be George Gaskoin, of 7, Westbourne Park. The prize will be presented by the Rev. E. Wyatt Edgell at the next ordinary meeting, February 8. The inaugural address was delivered by Dr. A. Carpenter, vice chairman of the Council.

ALL the members of the Royal Commission on Technical Instruction have returned to England. The chairman, Mr. Samuelson, M.P., remained at Paris for some days in order to obtain additional information on the general policy of the Department of Public Instruction. The selection of the members of the Commission, on account of their acquaintance with different branches of the inquiry, has proved very useful, Dr. Roscoe having been able to devote his attention more particularly to chemical technology, Mr. Philip Magnus to school organisation, and Mr. Slagg, M.P., Mr. Woodall, M.P., and Mr. Swire Smith to the bearing of technical instruction on the branches of industry with which they are familiar. It is proposed to take the evidence of experts in this country in February, and to visit Germany, Switzerland, and Belgium in the spring.

M. PASTEUR has been elected to one of the vacant seats in the French Academy.

PROF. FLOWER has just been appointed by the President and Council of the Royal Society a trustee of Sir John Soane's Museum in the vacancy occasioned by the death of Sir Philip de Malpas Grey Egerton, M.P.

WE have received from Messrs. De la Rue and Co. their pocket and desk diaries for 1882, together with beautiful cards and almost microscopic registers for use during the coming year. If possible all these are more beautiful examples of the printer's art than those produced in past years, and especially interesting from NATURE's point of view, at all events in the fact that the amount of scientific facts packed into the closely-printed page is greater than ever. The mechanical equivalent of heat, the present magnetic elements, the mean distance of the sun, and such like data, are all to be found in their proper place, while the astronomical portion is so full that the amateur astronomer will be spared many references to his *Nautical Almanac.*

ON Friday last took place the first distribution of prizes and certificates to the successful students in the various schools connected with the City and Guilds of London Institute. The Report showed the rapid increase of candidates at the examinations of the Institute, and Sir F. Bramwell gave an address, explaining what was meant by technical education, and the great benefit which must accrue to the various industries by the application to them of the scientific principles on which they were based.

SOME severe shocks of earthquake, accompanied by loud detonations, are reported by the *Valais Gazette* to have occurred at Sion and Sierre on Sunday the 4th inst.

WE learn on good authority that M. Cochéry is preparing a project for the protection of cables and the general regulation of telegraphy. It will be laid before the French Chamber of Deputies after the end of the recess, which will begin in a very few days.

A "SOLAR" locomotive has been placed on the French Northern Railway. It is so called owing to an electric light which is placed in front and fed by the engine itself, and intended to illuminate the way for a long distance in front.

A GEOGRAPHICAL and Natural History Exhibition has recently been opened at Gotha. It will close on the 20th inst.

THE additions to the Zoological Society's Gardens during the past week include a Pomatorhine Skua (*Stercorarius pomatorhinus*), British, presented by Mr. George H. Baxter; two Kestrels (*Tinnunculus alaudarius*), British, presented by Mr. F. Usher; a Horrid Rattlesnake (*Crotalus horridus*) from Brazil, presented by Dr. A. Stradling, C.M.Z.S.; a Dwarf Chameleon (*Chamæleo pumilus*) from South Africa, presented by Major Hunt; a Common Jay (*Garrulus glandarius*), British, presented by Mr. J. Young; two Cape Crowned Cranes (*Balearica chrysopelargus*) from South Africa, a Giant Toad (*Bufo agua*) from Brazil deposited; a Red Kangaroo (*Macropus rufus*), two Mocassin Snakes (*Tropidonotus fasciatus*), born in the Gardens.

SOLAR PHYSICS[1]

I.

I HAVE to address you in this course of lectures on what we know of the infra-red end of the spectrum and its relation to solar physics. I will commence by asking a question, and endeavour to answer it in such a way as will, I hope, be understood. The question I propound is, How do we know that there are any rays below the red rays of the spectrum? In answering the question I would beg you to remember that every body in motion possesses what we call energy, or a capacity for doing work, be the motion a wave motion or a direct motion. Let us take one or two examples of waves: first, that of water, which is familiar to us. I need scarcely point out that a wave of the sea is capable of doing an immense amount of work, not to say mischief; there is no doubt, then, that it is capable of doing work, and this we may take as the true definition of energy, existing in a body, viz. the capacity of doing work. Whence, then, does a wave derive its energy? Perhaps we may have to travel many miles from the place where we find our wave. Travelling to the origin of the waves, we shall no doubt find that a wind has generated them, and in reality it is the energy possessed by the wind which is carried by the waves to the distant shore. The energy possessed by the wind has not been directly expended on our coast, but when transmitted by the waves this same energy is applied in different manner, and by this difference in application it becomes effective. We all know, for instance, that a child may ring a church bell if he give a pull at the right intervals of time, and so, by timing the impact of waves correctly, it is possible for them to do work which in any other way would be impossible. Another example of the energy of waves is the tuning-fork, as in the experiment which Mr. Lockyer showed you. You will recollect that he demonstrated that if one tuning-fork was brought near another of the same pitch the second took up the vibration of the air. The tuning-fork which was struck, or bowed, generated waves in the air carrying some part of the energy of the vibrating prongs to be expended on the second tuning-fork, and as this tuning-fork vibrated in the same period as the first one, each blow of the air-waves was essentially well-timed, and the fork was thus set in motion. You will also recollect that a a fork not of the same pitch—that is, not sounding the same note—was unable to cause vibration in the second fork; and this was simply because the energy was applied at wrong intervals of time. In the case of the tuning-fork, then, the air is the medium through which this energy was conveyed.

With light we have the same kind of motion in the luminiferous ether: the motions of the molecules swinging in the source of light may, for the sake of illustration, be looked upon as composed of an infinite number of tuning-forks, the ether, instead of the air, carrying their energy in all directions. How can the energy in the ether show itself? In the first place it must meet with some obstruction, and secondly that obstruction must be capable of vibrating with it, and thus damp or destroy the waves. The destruction of the wave motion in the ether is known as the absorption, and thus we see that where there is absorption there work of some kind must be done. The work, then, that light can perform is this. [When I say light, I say it with a definite object. It has been said that it is nonsense to talk about dark light; but it is no more nonsense to talk about dark light than to talk of a white violet, a yellow rose, and so on. Therefore, I prefer to call the whole ether vibrations with which we are acquainted, light, until we get a more authoritative definition.] The work that light may perform then is this, it may cause certain appliances in our eye to vibrate (and perhaps also cause chemical decomposition on the colouring matter of some membrane which is placed near the retina), which gives us the sensation of vision. Secondly, it may cause the molecules of the material body on which it falls to vibrate more freely than they do when in a normal state of vibration, and thus raise the temperature of the body. (It must be recollected that physicists suppose the molecules of all matters to be in active vibration, and a rise of temperature simply means an increase of those molecular motions). In the third place it may cause the atoms which compose the molecules to vibrate more energetically than they do under ordinary circumstances, and cause one or more of the atoms to swing off, as it were, and thus create a new molecule; in other words, cause a dissociation of the molecule. We may sum up our definition by saying that the presence of light can be known by three distinct kinds of work. It may be known by its causing the sensation of vision; it may be known by a rise in temperature of the body on which it falls; and it may be also known by the chemical action which it induces. I think, then, we have an answer to the question which I propounded, How can we tell that there are rays which exist below the visible red of the spectrum? If they exist, they must be shown by a rise in the temperature of any body which may absorb those rays when placed in their path, or by their chemical effect. That they do not give rise to the sensation of vision I need scarcely say.

The dark rays were discovered in the years 1800 and 1801 by Sir William Herschel, who was investigating the solar surface with a telescope. Finding that the heat sent to the eye was unbearable, he wished to obtain some medium to cut off those particular rays which gave the heating effect. In order to do that he undertook a series of investigations of the spectrum, in what we should now call perhaps a rough kind of way, in a manner which I will show you on the screen. A beam of light was passed through a prism fixed horizontally against a slit in a wall, being bent so that the spectrum fell upon a table beneath, on which he ruled lines marking the boundaries of the colours. On a sloping board turning on castors he placed three thermometers in a line, two of which he caused to lie within the spectrum, the third remaining outside it. He then noted the height of the mercury in all three of the thermometers, and thus compared the two in the spectrum with that lying beyond it (I may say that the diameters of the bulbs of the two thermometers in the spectrum, which is rather an important point, were one-eighth of an inch and half an inch respectively). Not only did Sir William Herschel use thermometers, but he also used the principle of absorption to increase their indications, for he blackened those thermometers with China black. He found he got a greater effect by using lampblack than by using the bare bulbs of the thermometers. He commenced by placing his two thermometers in the violet, and he found he got a certain rise of mercury. Having made a scale in accordance with the ruled lines on his table, he set up at the point indicating the violet an ordinate also to scale, showing the number of degrees of rise in the thermometer at that particular point. Then in the indigo he set up another ordinate indicating the degrees of rise there, and so on at all these different points; so that he was able to construct, as it were, a mountain of the heat effect due to the spectrum in all parts (Fig. 1). Having gone in this way over the

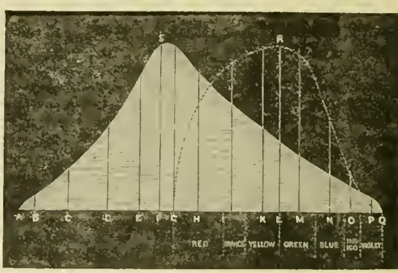

Fig. 1.

whole of the visible solar spectrum, he found there was a rise in the two thermometers, as he approached the red from the violet. (It must be recollected that before his time there was no knowledge of any rays which existed below the red). He therefore ruled lines on his table beyond the red, and having reached the limit of the luminous spectrum, he shifted his thermometers beyond, and found that they rose even higher than in the red. This led him to continue the experiment, and he found by going a long way beyond the red he still got a slight trace of rise in the mercury of his thermometers. By this means he was able to construct his well-known curve (which answers to a curve of energy) in the very simple manner shown in Fig. 1. I shall have to refer to this curve in another lecture, and I want you to fully bear in mind that the heights of every part of this curve answered to a comparative measure of the energy of the particular parts of the spectrum—

[1] Lecture delivered on May 25, 1881, at the Lecture Theatre, South Kensington Museum, by Capt. Abney, R.E., F.R.S.

in other words, to the comparative heating effect of different parts of the solar spectrum. Thus you see that Sir William Herschel, by the use of thermometers, was able to discover that there were rays existing below the red, and this he did by the second method, viz. by noting the rise of temperature in the absorbent body, lampblack, placed in the path of the rays. There are other modes of showing a rise in temperature in lampblack, amongst others by the thermopile, and to that I shall have to refer more at length in a subsequent lecture, and therefore I pass on at once to the chemical effect of the different rays of the spectrum.

In order to show you how we can arrive at a knowledge of the existence of energy in the different parts of the spectrum by their doing chemical work, I must take you through one or two very simple experiments, experiments which I dare say you may have heard of before, but the sight of which perhaps may impress your minds more than if you merely read of them. The first experiment will show the effect upon chloride of silver. I have in this frame a piece of paper impregnated with chloride of silver, and behind this screen, which I have had erected to save your eyes, is a Siemens electric lamp, which gives out a very intense light indeed. A lens placed at a proper distance from the points will cause an image of them to fall on this paper. After a few seconds' exposure you see that where the image fell we shall have a darkening effect; in fact we have an image of the arc printed on the chloride of silver paper. Now this paper apparently to all casual observation is white; what rays of the spectrum are they then that cause this blackening effect? By and by we shall have to find out to what this blackening is due. I have here some chloride of silver in collodion, and with this I think we shall be able to see what rays they are which affect the chloride of silver. In front of the slit of this spectroscopic arrangement we place this chloride of silver, and you will remark that the image of the slit cast by the prism on yonder white wall is of a lemon colour, and that the violet of the spectrum is much subdued in intensity. The true colour of chloride of silver in that particular state in which it exists in the paper then is that which absorbs the violet, and from what has been said on the principle of work being done where absorption takes place, we should expect to find that it is the violet rays which discolour that chloride of silver, and not the yellow rays, which, as we saw, passed freely through it. We will prove that. I have here a blue glass, and we will see whether we can print through the blue glass in the same satisfactory manner that we can when the light is unshaded. Placing a yellow glass in front of the light, first you see that there is no action whatever—the paper remains perfectly white. Now, taking the blue glass, and trying to print through it, you see we have a print of the arc—not perhaps quite so deep as where the unshaded light acted on the paper, but still sufficiently so to show that the blue and violet light are effective. The proposition enunciated then in this case is correct, that the rays active in the dissociation of chloride of silver are the rays it absorbs. But we may consult the spectrum still further, and, by placing such a piece of paper directly in it, and allowing it to print, we shall find that the chloride of silver is only attacked by the blue and violet rays, and not at all by the yellow. Such, you see, is the case in the photograph before you. There is an invisible part of the spectrum beyond the violet by which the silver chloride is even more affected, but that is a region of the spectrum with which I will not trouble you, as it is beyond the scope of my lectures. It will be seen then that we have a specimen of the chemical decomposition of a solid body. Now I should like to show you what is the cause of that darkening; namely, how the chloride of silver is changed. I am obliged to use chemical symbols, because they are short, but I will try to explain them. In ordinary chemistry the chloride of silver is designated AgCl, Ag meaning one atom of silver, and Cl meaning one atom of chlorine, which are joined together. But in order to explain phenomena which are met with in photography, silver really requires two atoms of chlorine to be combined with it to form chloride of silver; that is silver is a *diad* element. This I have expressed by this symbol which I have here, $Ag''Cl_2$; that is two equivalents of chlorine are obliged to be combined with one equivalent of silver. I will give the reason why the old formula is not perfectly correct: when you have light acting on chloride of silver, work of some description is done amongst the atoms of the molecules forming it, and we have one atom of chlorine thrown off by the vibrations of the blue part of the spectrum, and the new molecule $Ag''Cl$ is what is formed, which will grasp any other unsatisfied atom or molecule which may come in its way. In chloride of silver, then, we have an example of the decomposition of a solid body by the action of light. I have here two bottles, both containing ethyl iodide, a body which we will say roughly is composed of ethyl and iodine combined together; the action of light on this is to cause the iodine to separate from the ethyl, and the iodine liberated colours the liquid, as we have it in one bottle. The other bottle is ethyl iodide unaltered by light. So that you see we are obliged to shield this liquid from the light in order to prevent it from decomposing into ethyl and iodine. Here we have decomposition of a liquid by light.

I will now endeavour to show you the decomposition, or dissociation, which is perhaps a better term, of the molecules of a gas, and its combination with something else. I have here a jar of chlorine, and I think you will see by holding it in the rays of the spectrum that we have certainly the violet cut off, and a good deal of the blue. Therefore, if we find any work can take place within this chlorine it must be by those rays which are absorbed or cut off. I have here a jar of hydrogen which is perfectly colourless, and were I to put that in the spectrum I should teach you nothing, because the whole of the rays would pass through it. If then I have a mixture of hydrogen and chlorine together, and allow light to act upon them, it is quite evident that the only matter which can be acted upon is the chlorine. Now, in these small glass bulbs which are covered with yellow paper, are equal volumes of chlorine and hydrogen. When chlorine and hydrogen are combined together we have what is known as hydrochloric acid, a gas of the same tenuity as a mixture of the two. It has been found by practical experiment that if you have an intense source of light acting upon chlorine and hydrogen a combination between these two at once takes place, and we have the hydrochloric acid formed with a violent explosion—not enough to do any harm, but one which will make the room echo. Now our conception of the matter is this, that no hydrogen atom can exist by itself; that there must be two atoms to form hydrogen molecules; and that there must be at least two atoms of chlorine to form a chlorine molecule, perhaps more. Anyhow, you cannot have less than two atoms to form one molecule of chlorine, or less than two of hydrogen to form a molecule of hydrogen. If then we have these two mixed together, and cause light to act upon them, what is the physical result? The physical result is that the atoms of chlorine will swing violently apart from one another, they will be dissociated, and in their swing will catch up one of the atoms of hydrogen, and hydrochloric gas will be formed. Now you saw that the mixture of chlorine and hydrogen, or rather that the chlorine itself cut off the blue; in other words, it was the blue light which would have any chemical effect upon the mixture. I will now get Mr. Greening to allow the Siemens light to act through red glass, and you will see, I think, that there will be no effect whatever. Now, directly he takes it away there is a violent combination of the two with an explosion. To show that it is the blue light that is the effective light we will cause those two gases to explode by means of white light filtered through blue glass. I may say that the arrangement is very simple. We have the Siemens light; a lens brings the rays from that Siemens light to a focus on the centre of the bulb, and the vibration of the ether proceeding from those points causes those two molecules to combine in the way that you saw just now. We will put the blue and yellow glasses together first, and start the Siemens machine; when we draw away the yellow glass we have the same result as before.

For photographic purposes silver salts are the most convenient; if, however, we had to wait until the silver salts visibly darkened before we obtained a photograph, we should have to wait much longer than it is in the experience of all that we have to do. I will try and explain what happens when a very short exposure is given to a silver salt. For certain reasons silver chloride is not used, but we have recourse to silver iodide or silver bromide, and in some cases where both are used together a better result is obtained. What happens to these salts by a short exposure? What happens to silver chloride when acted upon by light? You will remember I told you that (with our notation for silver) after light had acted on silver chloride we had one atom of silver combined with one atom of chlorine. In the same way, if we replace the chlorine by iodine we have sub-iodide of silver formed. The visible image and the image impressed by a very short exposure are identical except in the quantity of matter altered. We will suppose, for instance, according to the modern theory that each of these molecules are charged with electricity,

with one kind of electricity. These sub-molecules, the sub-iodide and the sub-chloride, are unsaturated compounds, and are ready to join hands with any body for which they have the least affinity. Suppose then we have a solution of a silver salt, say of silver nitrate, and that we introduce some body which will precipitate that silver in a metallic state, and suppose again that one atom of silver as it is precipitated is charged with one kind of electricity, it is quite within the range of probability that the silver atom, as it is precipitated in the solution, may be attracted by the sub-iodide of silver when charged with another kind of electricity, and so form a new molecule as it were. This built-up molecule will not be fully satisfied, but probably have an excess of the opposite kind of electricity, with which the sub-iodide was charged, and the silver atoms which were oppositely charged to those first attracted would in their turn be attracted, and so on until the image is, as it were, built up on the small quantity of sub-iodide first formed by the action of light. In the case of silver bromide we have the same thing happening. We have sub-bromide of silver formed, which is represented by one atom of silver, and one of bromine, Ag″Br, and it is quite within the range of possibility that another body may be brought in contact with that, which, being charged with electricity opposite in polarity to that with which this molecule is charged, may attract away, as it were, the bromine, and thus leave the metallic silver itself behind. This is what happens really in the case of what we call alkaline development. In the first case we had acid development, or an image built up by the deposition of silver from silver nitrate, and in the other abstraction of bromine from the small quantity of sub-bromide of silver which is formed by the action of light. The image so built up, however, would scarcely be apparent, since the metallic silver thus formed would be inappreciable to the eye. Another phenomenon seems, however, to present itself, and that is, that the atoms of metallic silver, and of the unaltered bromide of silver, are oppositely charged with electricity, and combine to form fresh sub-bromide of silver; these new molecules of sub-bromide are reduced, and so the action goes on till an image is built up, each molecule of sub-bromide originally formed by the action of light forming a nucleus for the reduction. If instead of forming the iodide and bromide of silver in collodion films, as is usually the case now, we form iodide and bromide of silver on a metallic silver plate by allowing iodine and bromine vapour to have access to it, and if, after exposure to light, we allowed mercury vapour to act upon it, then the same kind of action would take place, the condensed mercury vapour would be attracted to those points which had been acted upon by light. That is the earliest form of photography, and was known as daguerrotype.

I now propose to show you a practical demonstration of the two methods of development of which I have shown you the outlines by diagrams. First, I will ask you to notice the part of the spectrum which the silver iodide plate cuts off. I have placed such a plate in front of the slit of the lamp, and you will see the blue is cut off. Iodide like chloride cuts off the blue rays, but with more intensity than the chloride. Where there is absorption there alone can work be done, the blue rays are therefore most effective in altering iodide of silver. I have a photographic spectrum apparatus placed in position. We have the Siemens light as before, a collimating lens (about which I need not enter into details), a prism through which the light has to pass from the slit, and here we have a lens and an ordinary camera. I propose to place a plate coated with silver iodide in the spectrum of the arc, and another coated with bromide, and then develop them if possible on the screen before you by the two methods of development. The first plate we expose is an ordinary wet plate, *i.e.* we have a collodion film which covers the plate, and this collodion film contains iodide of silver, and it is moistened with nitrate of silver. We will expose that to the spectrum for a second. I have in front of the slit at present a solution of bichromate of potash, which cuts off the blue, and therefore the light passing through would have no effect on the plate. I withdraw the front of the slide, and give a very short exposure. Now we will take a cell, F, containing what we call a developing solution, that is, something which will precipitate metallic silver from the soluble nitrate of silver; we will place it upon the stand of the lantern, B, and by means of the lens G we shall see a reversed image of part of the cell on the screen. I next place a piece of yellow glass, E, in front of the lantern lens. I take the plate and simply immerse it in the solution, and by degrees you will see a blackening take place. I am afraid the film is a little too intense—it is now coming out more rapidly and more vigorously; and here we have the image of the blue end of the spectrum perfectly developed. I will get my assistant to take charge of this, and in the meanwhile I will throw on the screen another spectrum which was taken in a similar manner.

Now we will try the other mode of development, which I hope will be more visible to the audience than the one we have tried. We will use the Siemens light again to form the spectrum. We will keep the yellow solution in front to cut off the blue rays whilst focussing it, and then I am perfectly safe. Then we will remove the yellow solution, and give a very short exposure, and we will develop by the alkaline process. We will use the same apparatus as before for developing. We have here a cell containing the liquid which has a great affinity for bromine, and I have no doubt we shall find that the solution will take away the bromine and leave metallic silver behind. It will probably be rather slower than the other in appearing. The plate is now placed in the cell, and we see the lines of the spectrum are appearing, and finally the image is fully out. I now withdraw the yellow glass.

You may ask how it is I can afford to let the light fall on th plate without causing a further deposition. The fact is, this solutio

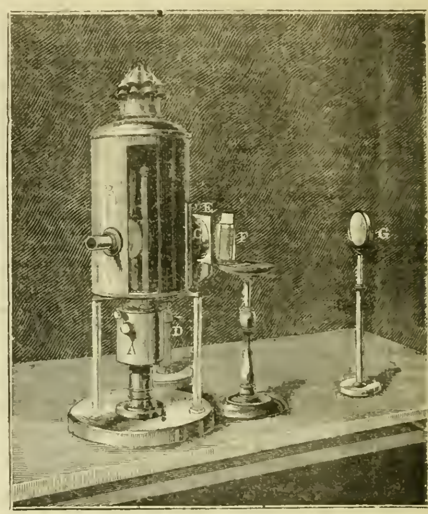

Fig. 2.

itself is coloured red,[1] and therefore the light passing through it has no effect on the bromide. I daresay by and by, when those pictures are thrown on the screen, you will be able to see what kind of spectrum we have got. You will remember, then, that we have in these methods of development which I have endeavoured to bring before you two kinds of chemical action—one a physical action of attraction exercised by sub-iodide of silver, the other a chemical one by the taking away of bromine from the silver salt.

The first mention that we have of a photographic spectrum in the red or below the red was in the year 1839, when Dr. Draper published a paper saying that he had been able to observe certain lines in the solar spectrum below the limit of the red. I propose to show you on the screen a copy of his photograph, and explain how it was taken. Dr. Draper proceeded in this way. He took a daguerreotype plate, exposed it to light first, then exposed it to the spectrum. In Dr. Draper's spectrum we have the whole of the blue and violet part of the spectrum delineated, but in part of the green and all of the yellow there is a blank, but be-

[1] The plate was developed by ferrous oxalate.

low these the lines in the red A and B in the red are shown; but still lower down there are three lines delineated, which he calls α, β, γ. Recollect the way he proceeded. He exposed the daguerrotype to light, and he allowed the spectrum to fall upon it. What was the meaning of that? The meaning of that was he altered the iodide of silver to begin with. I have here a piece of iodide of silver paper. One half has been exposed to light, and the other has not been exposed to light at all, and you will see the difference in colour. One has a greenish brown tint, and the other a decided yellow. The yellow you saw cut off the blue; the brown tint, if you put that in the spectrum, would allow the yellow to pass, but would cut off not only the blue but also some of the red too. How then do we explain this action? It is true he found that these lines, A, B, α, β and γ, had impressed themselves, but he found they were what we call reversed lines, that is to say, what ought to be black before were white, and what ought to be white before were black. How can this be explained? The spectrum was the same, the iodide of silver

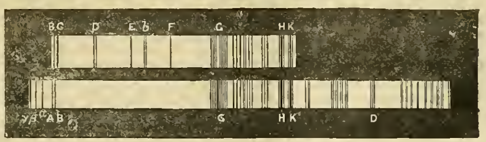

Fig. 3.

plate was the same. All was the same except the previous exposure to light. Now, this remained unexplained for a long time. It was supposed there was a certain antagonism between the rays, that is to say, that the red rays were able to undo the work which the blue had done, and that the yellow remained neutral. But was this an explanation? There can be no such thing as antagonism of energy in this matter, and therefore it required some further explanation.

In investigating the subject it fell to my lot to try experiments on the constitution of the photographic image, and my experiments led me to find that what was supposed to be antagonism of rays in the red part of the spectrum to those of the blue was nothing else but another chemical action which was called into play.

I have here a negative of a line drawing. I place a collodion plate containing iodide of silver in contact with it, but before I develop it I will place half of it in a solution of peroxide of hydrogen, which is an oxidising solution, and on developing I find only half the image has appeared, viz. the part which was not placed in the oxygen peroxide; to adopt the old explanation, there is an antagonism of the peroxide of hydrogen to the action of light! This gave a clue to Dr. Draper's reversal of the image which he got in the red rays of the spectrum. I will show you what it occurred to me did happen. Dr. Draper's plate after it had been exposed to light contained molecules of sub-iodide of silver, and when he allowed the spectrum to play upon it the sub-iodide of silver was anxious to obtain anything it could to satisfy itself, and so took up oxygen from the air and formed an oxy-iodide of silver, Ag″I, combined with oxygen, and that oxide of silver was totally incapable of development. Why? Simply because its energy of attraction was satisfied; there was nothing to attract the mercury condensed from the mercury vapour by which his image was developed. This then might be an explanation of Draper's photograph which should be capable of proof, and in order to prove it I will show the way I proceeded. I will take a plate of iodide of silver and expose it to light before you; then I propose to immerse it in a cell containing an oxidising solution of very delicate peroxide of hydrogen, which, as we know, is a very strong oxidiser, in fact one which will give up oxygen very freely to anything brought in contact with it. I have an arrangement by which I can do that, consisting of a dark slide in which I can put the cell and the silver plate. *Here* you see the prepared plate in its normal state. The electric light is allowed to act upon it, and of course the iodide of silver will be reduced to sub-iodide. I shall next allow the spectrum to play on the plate whilst immersed in this oxidising solution, and see if we cannot get the same results that Draper did in his reversed spectrum. If the theory that I give of the production of Draper's oxidising photograph is correct, then the red light ought to aid the oxidation of the photograph, or rather of the subiodide, forming that oxyiodide of silver which I mentioned to you. I will leave the bichromate cell in front of the slit in order that you may see the blue rays have nothing at all to do with the matter. I will give rather a longer exposure than I did before, and in that way I think I shall be able to get a result. I will give it to my assistant to develop, and then throw it on the screen as soon as he has finished with it. Now what shall we expect to find in this photograph? If the red rays help the oxidation of the iodide we shall expect to find that where the red rays are active no development whatever will have taken place, and as a fact that is really what we find. This method of Draper's, of photographing the ultra-red part of the spectrum, is exceedingly inconvenient, as it requires a long exposure, and, I may say, is unsatisfactory, because it gives very bad definition. You have to use a very open slit in order to get it.

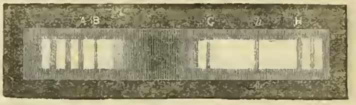

Fig. 4.

I now throw on the screen a portion of the *solar* spectrum taken in the way I have just carried out before you. In it you will see a facsimile almost of Draper's photograph. The question arises, what would happen suppose the plate was immersed in a deoxidising solution such as potassium nitrite? We have the answer at hand in the shape of a photograph so exposed. The reversal, you see, is entirely absent.

Now the question comes, Is it possible to show the existence of the ultra-red rays of the spectrum by visible means? in other words, by the exposure of any surface to the light? I think I can show you that it is possible by Balmain's phosphorescent paint. If I expose this to the light of the electric lamp we shall find that of course it will become very luminous indeed. Now when I expose this luminous surface to the action of the spectrum something ought to happen, perhaps which will give us an idea of Draper's photographs. I will try, and then I must pass round this luminous plate, because you will not be able to see it at a distance. I bring the light to a focus on the slit of the spectroscope, and place the surface of the paint, which is still luminous, in the spectrum for a short period, and now I will pass it round, and you will be able to see the phenomena; first of all a bright patch, and then a black patch beyond. The bright patch is caused by the blue rays; the black patch beyond is caused by the ultra-red rays, the red rays and the yellow rays; in other words, these rays have the property of quenching the vibrations of the phosphorescent particles, so that you see we have a means of showing visibly the existence of the ultra-red rays of the spectrum.

Our knowledge of the value of the photography of the spectrum, as regards its most refrangible portion, was very limited indeed until Mr. Lockyer took up the subject of spectrum photography with earnestness. In the year 1872 at Chatham we also began our researches in this matter, and we hoped that what we had found to be so immensely valuable in the violet and the blue regions of the spectrum—we might also be able to accomplish for the red and ultra-red rays of the spectrum as well. In the year 1872 Vogel made an important announcement, which, if it had proved everything one could have wished, would have left no need for further experimentation. He said if you took a bromide of silver plate or iodide of silver plate

and covered it with a dye, that in the spectrum, where the dye absorbed, there a photographic action, although beyond the usual boundary of photographic action, would be seen. We followed up this very carefully, hoping to find some dye by which we might be able to photograph the ultra-red rays of the spectrum. Had I known as much then as I do now I should not have followed any such chimerical idea. But what Vogel stated was perfectly correct, viz. that in that regions of the spectrum which certain dyes absorbed, a photographic action would take place. Suppose I take a plate prepared with some silver salt, and flow over it a dye, and then expose it to the spectrum; I find where the dye absorbed there a photographic image was formed. What was the meaning of this? This required investigation as well. The first dye that was taken up was that of cyanin blue. I have here a plate covered with cyanin blue, and when this plate was placed in the spectrum it was found that it bleached in the yellow, No. II. Fig. 5. Now what was the meaning of that bleaching in the yellow? Let us consult the absorption spectrum of cyanin blue, to see whether it absorbs in that particular part of the spectrum; for if it absorbs in that particular part there work must be done as I have already shown you. I will throw the spectrum on the screen, and then introduce a solution of cyanin blue in front of the slit of the lantern, No. I. Fig. 5. We do this, and it will be seen that there is great absorption in the yellow, so that that particular portion of spectrum bleached the cyanin blue which the cyanin blue cut off. So that work and absorption went hand in hand: when the action was investigated more closely, it was found

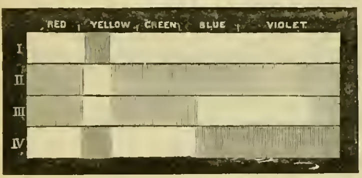

FIG. 5.—I., absorption spectrum of cyanin blue; II., bleaching effect of spectrum on paper stained with cyanin blue; III., bleaching effect of spectrum on a silver bromide film stained with cyanin blue; IV., photographic impression of spectrum prepared as in III. The shaded parts show metallic silver on development.

that the work performed was an oxidation; in other words, that bleaching took place through the effect of oxidation. So much for cyanin blue, *per se;* when, however, we took a plate covered with bromo-iodide of silver in collodion, and dyed with cyanin blue, exposing it for some time to the spectrum, it was found not only that the cyanin was bleached in the yellow, but it was also bleached in the blue, No. III. Fig. 5. It should be remembered that the only factor of difference was in the first case we had cyanin blue, in the collodion by itself, and in this last the dye and iodide and bromide of silver. What then was the explanation of this? That required a further investigation, and I think, perhaps, I shall be able to show you what really did happen. I will take that same cell of cyanin blue used before, and place it in front of the slit of the lantern, and we have the cyanin absorption spectrum on the screen. Now I have told you that when bromide of silver or iodide of silver is exposed to light, one atom of iodine or bromine is given off, and if the exposure be prolonged the amount is measurable, therefore it is possible that the bleaching action in the blue might be due to the action of bromine, and if so, bromine ought to be able to bleach cyanin blue. If we take bromine water and drop it into the cell, I think you will find that the whole spectrum will appear again in its usual brilliancy; we drop the bromine water in, and the whole spectrum does appear on the screen. Our question then is answered. The bromine liberated from the bromide of silver by the action of light when the dyed film was placed in the spectrum, was able to bleach it in the blue part of the spectrum in the same way that the oxygen in the air was able to bleach it under the influence of the yellow rays.

Now I will show you what the action of oxidised matter on silver is. Here we have a glass plate on which was written "May 25th" with an oxidised solution of albumen. This was coated with a collodion film containing bromide and iodide of silver, and developed in the usual way. You will see that where the oxidisable matter is placed, there we have a deposition of silver upon those particular portions. Apply this to the spectrum developed on a plate stained with cyanin blue; where it is bleached in the yellow, the oxidised dye will cause a deposit of silver to be formed,[1] whilst where the blue rays have acted we shall have a deposition of silver due to ordinary development, as already explained. I throw upon the screen a spectrum showing this. The film of collodion containing the silver salts was dyed, and then the bromide of silver dissolved away. You see we have a bleaching in the yellow and also a bleaching in the blue, one being due to the oxidising action of the yellow rays on the plate, the other due to the action of the bromine upon the dye itself. Next I will show you a photograph (No. IV. Fig. 5) of the spectrum taken on such a dyed plate. We have the part impressed by the blue rays, and a deposition of silver as before, and also we have the yellow where there is another strong deposition of silver. For convenience' sake I have photographed the absorption spectrum of cyanine and placed it below the spectrum photographed on the silver stained with cyanin. You will thus see that the band in the yellow impressed on the latter plate corresponds exactly with the absorption of the cyanin blue itself.

Carrying the investigation a little further, it was found that the same took place with eosin. I have an eosin solution here, and here is an absorption-spectrum of eosin which cuts off a great deal of the green—we have the yellow, but the green is cut out and the blue is damped. The green is the principal portion which is absorbed; in other words, the work which has to be done on the dye will be done in that part of the spectrum. In the photograph of the spectrum of eosin taken with bromide of silver dyed with eosin, you see as a result that we have the plate impressed by the blue rays, and also the plate impressed by the green. The deposition of silver on the two parts is due to different causes: that in the green is due to the work done on the dye; the work was not done on the silver directly, but on the dye first. That on the blue was due to the work done on the silver bromide itself. I may say that all dyes which I have found useful in the photographic sense are what we call fugitive dyes; in other words, dyes which fade in the light. Ladies are perfectly well acquainted with the fact that some dyes will not stand well; those which fade most rapidly give the best results in spectrum photography.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Clothworkers' Exhibition for proficiency in Physical Science, tenable for three years by an unattached student at Oxford or Cambridge, has been awarded to J. Davies. The next Clothworkers' Exhibition will be awarded for Physical Science by means of the examination for certificates to be held next July by the Oxford and Cambridge Schools Examination Board. Candidates must be non-collegiate students of one term's standing at Oxford or Cambridge, or non-residents who are prepared to enter as such.

The oral and practical examinations in the second part of the Natural Sciences Tripos concluded on Monday last (12th).

Prof. Stuart has now thirty-eight pupils in mechanism and engineering, and more space and new machinery are needed to meet their growing requirements. A new room measuring thirty-six by twenty-five feet is asked for, with motive power, a heavy lathe, a slotting machine and larger forge. Messrs. Greenwood and Batley will present a slotting machine when there is a place to put it in. The building will cost 225*l*.

Mr. D. MacAlister, Fellow and Medical Lecturer of St. John's College, will lecture on Methods of Physical Diagnosis three times a week next term, beginning February 2.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, December 3.—Sir John Lubbock, Bart., president, in the chair.—Mr. J. Harris Stone exhibited specimens of the dried plant and made remarks on *Lychnis viscaria* as a

[1] It has been objected by Dr. Vogel that the bleaching action requires time to effect it, and that the phenomenon is visible after a short exposure. The simple answer to the question is, When does the bleaching commence? The merest trace of reduced dye would act as a nucleus for development, as does the merest immeasurable trace of subiodide or bromide.

trap for ants. He pointed out that three or four glutinous or sticky rings are situate immediately underneath the nodes in the flowering stalks. Ants climbing the stems are arrested and die in numbers at the sticky zones, and few reach the flower. In Norway last summer he had observed as many as 95 per cent. of the plants with dead and dying ants thereon; and he therefore submits whether the zones are a protection to the flowers? the ants noxious? or that their dead bodies ultimately serve as pabulum for the plant? Dr. T. S. Cobbold exhibited diseased roots of *Stephanotus* which he had received from Dr. Masters. They swarmed with myriads of nematode worms and were also covered with minute Acari. He referred the worms to the genus *Leptodera*, and stated that thirty-three years back he discovered similar parasites in the shrivelled leaves of Gloxinias.—Dr. Maxwell Masters read a note on the foliation and ramification of *Buddleia auriculata*. He shows from a study of the mode of development and other considerations that the leafy auricles between the petioles represent leaves of a whorl, so that the verticil consists of two perfect and two imperfect leaves. An additional link between Loganiaceæ and Rubiaceæ is thus afforded. Further details were given concerning the multiple axillary buds in this plant and the supra-axillary shoots. Some of the peculiarities alluded to are usually explained on the hypothesis of fusion, but the author shows that in this, as in many similar cases, the appearances are due to an arrest of development, in consequence of which parts that should become free in course of growth remain inseparate, and in some cases are "uplifted" with the axis as it lengthens, and are thus removed from their normal position.—Prof. Owen read a paper on the homology of the conario-hypophysial tract, or the so-called pineal and pituitary glands. He propounds the view that it is the modified homologue of the mouth and gullet of Invertebrates; that the sub-œsophageal ganglia or ganglionic masses or neural cords constitute the centres whence are derived and caudally continued the homologues of the Vertebrate myelon.—Mr. McLachlan communicated a paper on the Neuroptera of Madeira and the Canary Islands. Prompted by the researches of the Rev. A. E. Eaton in November and December, 1880. The author gives a *résumé* of all that had been published on the subject, and a tabular statement of the species found in the islands, indicating those known also to exist in Europe. In all about 53 species had been noticed from the islands, of which 19 are known inhabitants of the European continent, and 4 African; 37 species had been found in Madeira, 31 in the Canaries, 16 being common to both. The paper concluded with a detailed account of the species, including descriptions of several new ones.—The following gentlemen were balloted for, and elected Fellows of the Society:—Capt. P. Greene, G. S. Jenman, W. Landau, E. G. Warnford Lock, Rev. T. P. H. Sturges, Lieut.-Col. C. Swinhoe, G. C. Walton, C. S. Wilkinson, G. S. V. Wills, and Rev. Geo. Wilson.

Mathematical Society, December 8.—Mr. S. Roberts, F.R.S., president, in the chair.—Mr. G. H. Stuart, M.A., late Fellow of Emmanuel College, Cambridge, was elected a Member, and Miss C. A. Scott was admitted into the Society.—The following papers were read:—On the polar planes of four quadrics, Mr. W. Spottiswoode, Pres. R.S.—On some forms of cubic determinants, Mr. R. F. Scott.—On the flow of a viscous fluid through a pipe or channel, Prof. Greenhill.—The covariant which is the complete locus of the vertex of the involution pencil of tangents to a cubic, Mr. J. J. Walker.

Chemical Society, December 1.—Prof. Roscoe, president, in the chair.—The following papers were read:—Researches on the laws of substitution in the naphthalene series, Part ii., by Dr. Armstrong and Mr. Graham. The product of the action of cold sulphuric acid on β naphthol proves not to be identical with the isomeric sulphonic acid of Rumpf, but to be β naphthyl-sulphonate. The same substance may be obtained pure by the action of sulphochloride on β naphthol. By studying the reactions of this body the authors prove that bromine and the sulpho group do not assume the same position in the body when the sulphate is treated with bromine and sulphochloride respectively, and express the opinion that modifications of the OH group appear to lead to important modifications of the laws of substitution. A third and a fourth isomeric naphthalene-disulphonic acid have been obtained.—On benzylphenol and its derivatives, by E. H. Rennie. The author has obtained a monosulphonic acid and its salts in a crystalline condition. He has investigated the action of nitric acid and of bromine on the salts. He believes benzolphenol to be a para derivative.—Note on the action of ethyli chlorocarbonate on benzene in the presence of aluminic chloride, by E. H. Rennie.—On peppermint camphor and some of its derivatives, by R. W. Atkinson and H. Yoshida. The authors have studied the action of bichromate on this camphor. Menthone is produced; from its reactions the authors conclude that the relation between menthol and menthone is similar to that between borneol and camphor. They have examined the physical properties of these derivatives, and give the probable constitution of these bodies.—On the production of oxalic acid from paraffin oil, by J. Galletly and J. S. Thomson. The authors have acted on paraffin oil from shale, with nitric acid, and find that oxalic acid is produced.

Physical Society, November 26.—Prof. W. G. Adams in the chair.—Mr. C. Vernon Boys read a paper on integrating apparatus. After referring to his original "cart" machine for integrating, described at a former meeting of the Society, he showed how he had been led to construct the new machine exhibited, in which a cylinder is caused to reciprocate longitudinally in contact with a disk, and give the integral by its rotation. Integrators were of three kinds: (1) radius machines, (2) cosine machines, (3) tangent machines. Sliding friction and inertia render the first two kinds unsuitable where there are delicate forces or rapid variations in the function to be integrated. Tangent machines depend on pure rolling, and the inertia and friction are inappreciable. They are therefore more practical than the other sort. It is to this class that Mr. Boys' machines belong. The author then described a theoretical tangent integrator depending on the mutual rolling of two smoke rings, and showed how the steering of a bicycle or wheelbarrow could be applied to integrate directly with a cylinder either the quotient or product of two functions. If the tangent wheel is turned through a right angle at starting, the machine will integrate a reciprocal, or it can be made to integrate functions by an inverse process. If instead of a cylinder some other surface of revolution is employed as an integrating surface, then special integrations can be effected. He showed a polar planimeter, in which the integrating surface is a sphere. A special use of these integrators is for finding the total work done by a fluid pressure-reciprocating engine. The difference of pressure on the two sides of the piston determines the tangent of the inclination of the tangent wheel which runs on the integrating cylinder, while the motion of the latter is made to keep time with that of the piston. In this case the number of revolutions of the cylinder measures the total amount of work done by the engine. The disk cylinder integrator may also be applied to find the total amount of work transmitted by shafting or belting from one part of a factory to another. An electric current meter may be made by giving inclination to the disk, which is for this purpose made exceedingly small and delicate, by means of a heavy magnetic needle deflected by the current. This, like Edison's, is a direction meter, but a meter in which no regard is paid to the direction of the current can be made by help of an iron armature of such a shape that the force with which it is attracted to fill the space between the poles of an electromagnet is inversely as its displacement, and then, by resisting this motion by a spring or a pendulum, the movement is proportional to the current, and a tangent wheel actuated by this movement causes the reciprocating cylinder on which it runs to integrate the current strength. Mr. Boys exhibited two such electric-energy meters, that is, machines which integrate the product of the current strength by the difference of potential between two points with respect to time. In these the main current is made to pass through a pair of concentric solenoids, and in the annular space between these is hung a solenoid, the upper half of which is wound in the opposite direction to the lower half. By the use of what Mr. Boys calls "induction traps" of iron, the magnetic force is confined to a small portion of the suspended solenoid, and by this means the force is independent of the position. The solenoid is hung to one end of a beam, and its motion is resisted by a pendulum weight, by which the energy meters may be regulated like clocks to give standard measure. The beam carries the tangent wheels, and the rotation of the cylinder gives the energy expended in foot pounds or other measure. The use of an equal number of turns in opposite directions on the movable solenoid causes the instrument to be uninfluenced by external magnetic forces. Mr. Boys showed on the screen an image of an electric arc, and by its side was a spot of light whose position indicated the energy and showed every flicker of the light and fluctuation of current in the arc. He showed on the screen that if the poles are brought too near the energy expended is less, though the current is stronger, and that if the poles are too far apart, though

the electromotive force is greater, the energy is less; so that the apparatus may be made to find the distance at which the greatest energy, and so the greatest heat and light, may be produced.—At the conclusion of the paper Prof. W. G. Adams and Prof. G. C. Foster could not refrain from expressing their high admiration of the ingenious and able manner in which Mr. Boys had developed the subject.

December 10.—Prof. W. G. Adams in the chair.—New members: Lieut. C. E. Gladstone, R.N., Lieut. C. Gauntlett Dicken, R.N., Mr. Walter George Woolcombe, B.A., F.L.S., Rev. Prof. Sircomb, Mr. Arthur Clayden, M.A.—Prof. Adams said that it had been thought advisable to invite the members to view the Smoke Abatement Exhibition now opened, and the meeting was adjourned for that purpose; Prof. Chandler Roberts acting as guide.—The next meeting of the Society will be held on January 28.

Paris

Academy of Sciences, December 5.—M. Wurtz in the chair.—The first volume of the works of Cauchy, the first of a new edition of the works of Niels-Henrik Abel, and the scientific MSS. of Chasles, were presented and commented upon.—General survey map of France, by M. Perrier. This is a work of the geographical service of the War Department, and indicates, by curves, the orography of the country.—Meridian observations of small planets and of comet *b* of 1881 at Paris Observatory, during the third quarter of 1881, by M. Mouchez.—On the theory of chain-shot, by M. Resal.—On some applications of the theory of elliptic functions, by M. Hermite.—Chemical studies on the skeleton of plants, by MM. Fremy and Urbain. The substances forming the skeleton are chiefly pectose and its derivatives, cellulosic substances in their different isomeric states, cutose, and vasculose. The results of analyses of stems, roots, leaves, petals, fruits, and seeds, also of the tissues of champignons, are given. It is thought they may be useful to botanists for classification, for physiological studies, for study of manures, and fossil fuel, &c., and that they have also industrial uses.—Summary account of a zoological exploration in the Atlantic, in the *Travailleur*, by M. Alph. Milne-Edwards. This exploration was chiefly off the coasts of Spain and Portugal, in August. In one case dredging was done at the great depth of 5100 m., where numerous animals were met with, small indeed, but of high groups (annelids, crustaceans, &c.); the temperature was $+3^{\circ}\cdot5$. Near the Spanish coast, and beyond 1000 m. depth, numerous polypiers, mostly unknown, showed marvellous development at some points. Among other "finds" were three very rare sharks (at 1200m.), which seem never to leave the depths, a Norwegian Pontophile, which had been thought peculiar to northern seas, a new Pontophile, a gigantic Pycnogonidian, ten new genera of Bryozoa, magnificent corals of the genera *Lophohelia* and *Amphihelia*, a remarkable *Asteria* representing a new genus, an organism got at 1145m., which may belong to the group of Infusoria, and (there also) a fine *Eugliphus* like *Difflugies* of fresh water.—On certain meteorological stations it is proposed to establish in the neighbourhood of the North Pole, by M. Faye. He thinks little of the project. Its authors consider that the ice of polar regions is *perhaps* the regulator of our climates; but modern science shows the regulator to be rather in the vast equatorial zone, whence storms travel over the two hemispheres. After expounding his conception of these phenomena, Mr. Faye points out that France would do better to organise a meteorological station in the Azores rather than at Cape Horn.—On the theory of linear differential equations of the second order, by M. Brioschi.—Deposit of metallic layers of different colours by electricity, by M. Weil. Using a single copper bath, he can cover steel or brass *e.g.* with bright layers of such and such a colour at will, by means of different suboxides of copper, whose chemical nature is not yet determined. The same bath will produce the whole series of colours according to the manner of exposing the pieces. The effect is not one of thin plates.—Observations in 1881 on phylloxera and on the means of defence adopted, by M. Boiteau.—Observations of solar spots and faculæ at the Observatory of the Roman College during the third quarter of 1881, by M. Tacchini. An exceptional *maximum* of spots occurred in July (as predicted). The solar activity has gone on increasing, with special periods of greater frequency of spots, nearly corresponding, as before, to a half-solar rotation. The faculæ show a marked maximum in September.—On the spectrum of Encke's comet, by M. Tacchini. This, observed on November 8, had the three carbon bands (the central brightest) shaded off on the violet side; the weak continuous spectrum of the nucleus forming a uniform straight line across the bands.—On Wendell's comet (*g* 1881), by M. Tacchini.—Rectification and addition to a previous note on the curve of the solar spots, by M. Duponchel. He predicts that the next sun-spot maximum will not be before 1890 (others say 1882), perhaps 1888, but more probably 1892.—On the curves defined by differential equations, by M. Poincaré.—Distribution of energy by electricity, by M. Deprez.—On the determination of the ohm; reply to M. Brillouin, by M. Lippmann.—Variations of the resistance of electric machines with their velocity, by M. Lacoine. He shows reason for thinking these variations are explained by those of contact between the movable commutator and the springs in friction.—Determination of the illuminating power of simple radiations, by MM. Crova and Lagarde. Sunlight and a Carcel lamp were compared. Part of the spectrum is isolated with a slit, and a Nicol turned till striæ cease to be perceptible. With the lamp the maximum corresponds to the radiation 592; with the sun, to 564.—On the velocity of cooling of gases at high temperatures, by MM. Maillard and Le Chatelier.—Combination of hydrogen with oxygen under the influence of electric *effluves*, by MM. Deherain and Maquenne. The state of humidity of the surfaces between which the *effluve* is produced affects profoundly the nature of the discharge, both as to external aspect, and to its action on the gases.—On the titrage of œnoline and œnotannin in wines, by M. Jean.—Meteorological observations during a balloon ascent on October 20, 1881, by MM. Duté, Poitevin, and Du Havel. These relate chiefly to formation of clouds.—Observation of palpebral reflex in chloroformic anæsthesia, by M. Berger.—On the convulsing action of morphine in mammalia, by MM. Grasset and Amblard. All researches on the antagonism of various medicaments to morphine should be revised, the substances opposing the soporific effects, and those opposing the excito-motor effects of the alkaloid, being studied separately.—Researches on the history of generation in insects, by M. Jobert.—On the post-embryonal development of diptera, by M. Viallanes.—Researches on the action of digestive juices of cephalopoda on amylaceous matters, by M. Bourquelot. The liver and pancreas produce or contain a ferment which has no action on raw fecula, but which changes hydrated starch into sugar.—On the diamantiferous beds of Minas Geraës, Brazil, by M. Gorecix.—M. De Lesseps gave some information with regard to the scheme for piercing the Isthmus of Corinth.

Vienna

Imperial Academy of Sciences, December 1.—V. Burg in the chair.—The following papers were read:—R. Andreasch, on some further examples of syntheses of the sulphydantoins by means of thioglycollic acid.—Anton Tomaschek, on the power of movement of pollen-bags and pollen-tubes.—W. F. Loebisch and Dr. A. Looss, on the action of carbonic oxide gas on monopotassium glycerate.—On the preparation of dipotassium glycerate, by the same.—T. Hann, on the monthly and yearly oscillations of temperature in Austro-Hungary.

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THURSDAY, DECEMBER 22, 1881

ARCTIC SUCCESS AND DISASTER

THIS has been a stirring Arctic week. First we have the publication of one of the most remarkable narratives of one of the most successful Arctic voyages ever made, to which we refer in detail on another page. On Tuesday an influential deputation waited on the Earl of Northbrook, to urge upon Government the necessity of sending out an expedition to succour Mr. Leigh Smith in the *Eira*. And, also, on the same day, the wires which about two years ago transmitted the welcome news of the safety of Nordenskjöld's expedition in the *Vega*, and the successful navigation of the North-east Passage, bore to Europe the sad news of disaster to the *Jeannette*. Sad though the news be, it is not nearly so bad as was to be feared, for we doubt if many besides Mr. Gordon Bennett had any faith in the survival of the expedition, and the search parties that were to be sent out next spring were generally looked on as forlorn hopes. From the news which has been transmitted from Yakutsk to St. Petersburg, and thence to London and Paris, it is not quite easy to make out the details. The following extract is from the telegram of the St. Petersburg *New York Herald* correspondent to the Paris office of that paper; he quotes from a telegram to General Ignatieff, dated Irkutsk, December 19:—

"The Governor of Jakutsk writes that on September 14 three natives of Hagau Oulouss de Zigane, at Cape Barhay, 140 versts north of Cape Bikoff, discovered a large boat, with eleven survivors from the shipwrecked steamer *Jeannette*, who had suffered greatly. The adjunct of the chief of the district was immediately charged to proceed with a doctor and medicines to succour the survivors at Jakutsk and to search for the rest of the shipwrecked crew. Five hundred roubles have been assigned to meet the most urgent expenses. The engineer, Melville, has sent three identical telegrams, one addressed to the London office of the *Herald*, one to the Secretary of the Navy at Washington, the third to the Minister of the United States at St. Petersburg. The poor fellows have lost everything. Engineer Melville says that the *Jeannette* was caught and crushed by the ice on June 23, in latitude 77 and 157 east longitude. The survivors of the *Jeannette* left in three boats fifty miles from the mouth of the Lena. They lost sight of each other during a violent gale and dense fog. Boat No. 3, under command of Melville, having reached the eastern mouth of the Lena on September 29, was stopped by icebergs near to the hamlet of Idolaciro Idolatre on October 29. There also arrived at Bolonenga boat No. 1, with the sailors Hindmann and Hoross, with the information that Lieut. de Long, Dr. Ambler, and a dozen other survivors had landed at the northern mouth of the Lena, where they are at present in a most distressing state, many having limbs frozen. An expedition was immediately sent from Bolonenga to make diligent search for the unfortunates in danger of death."

From this and from the Reuter's telegram it would seem that Boat No. 1 has not yet turned up. The spot where the disaster overtook the *Jeannette* is a short distance east of the most easterly of the New Siberian Islands. The exact spots where the boats landed are not quite clear, and probably there has been some misspelling of names; but it is evident that it is somewhere on the complicated delta of the Lena. It will be remembered that the *Jeannette*, the old *Pandora*, was sent out two and a half years ago by Mr. Gordon Bennett, for Arctic exploration by the Behring Straits route. It now appears that Mr. Bennett's instructions were that the ship should keep by the east side of Siberia, and embrace the first favourable opportunity of making for the Pole. These instructions her Commander, Capt. De Long, had evidently been doing his best to carry out. She was last seen in September, 1879, when she was steering north-east from Wrangel Land. Probably she has run round the north side of the Island, and attempting the north-west route been caught in the drift like the *Tegetthoff*, and finally crushed. The sufferings of the unfortunate explorers must excite universal pity, though all will rejoice that it has not come to the worst with them. The route they took was a perfectly new one, and it is possible they may have something new and important to tell us. The expedition was in some respects of the old-fashioned kind, rushing blindly into regions about which absolutely nothing was known; but this is how all knowledge has been purchased. Still, had something of the scientific method of Baron Nordenskjöld been adopted, the result might have been different. Further news of the shattered but so far saved expedition will be anxiously looked for; they will have an exciting and terrible story to tell, but we trust that their sufferings will prove not barren of results to science. If they have established the existence of a line of islands to the north of the New Siberian Islands, one more of the Arctic problems will have been solved.

In view of this disaster, no doubt it will be a relief to many to learn that Lord Northbrook's reply to the deputation from the Geographical Society was quite favourable and that probably a relief expedition will be sent out for the *Eira*. At the same time we believe a Government expedition, however much Mr. Leigh Smith deserves, such attention, was not necessary; and we doubt much if Mr. Leigh Smith's relatives were not rather surprised when it was suggested to them that they should petition for Government assistance. Now that the search expedition is virtually decided on we wish it every success, at the same time hoping that it will be strictly confined to its ostensible purpose. To Government Arctic explorations we are certainly favourable; but we trust that the next expedition sent out will be constituted and organized on as thorough a scientific method as that in the *Vega*; and that, as in the *Vega*, there will not only be a special scientific staff, but that the real commander of the expedition, subject to contingencies of navigation, will be a man with the scientific training and methods of Baron Nordenskjöld. In short, let the staff consist of men trained in the various departments of science, and not primed in haste for the occasion.

The unfortunate disaster to the *Jeannette* will no more check Arctic exploration than many another greater disaster that has marked the progress of knowledge; it can only be hoped, while expressing our genuine sympathy with the sufferers, that Arctic explorers will learn from it all the lessons it ought to teach.

CHARLES LYELL[1]

Life, Letters, and Journals of Sir Charles Lyell, Bart., Author of the Principles of Geology, &c. Edited by his Sister-in-law, Mrs. Lyell. In two volumes. With Portraits. (London: John Murray, Albemarle Street, 1881.)

II.

In our previous notice of this work we have dwelt at some length upon the insight which it affords us concerning the origin and history of the book, which constitutes Lyell's chief title to fame. But the fact must not be lost sight of that, besides writing the "Principles of Geology," Lyell gave to the world a number of other books and original memoirs of the highest scientific value, though their fame has been overshadowed, to some extent, by that of his great work. The "Principles of Geology" was not, as some would have us suppose, a mere compilation from the works of other authors, for in every page of it we find embodied the results arrived at by the author after careful personal observation and close reasoning. Lyell, in a letter addressed to Edward Forbes, in 1846, very properly protests against the idea that original observations and theories are only to be published in journals of science and the proceedings of learned societies. He says:—

"On the Continent I gain no priority for any original views or facts which have only appeared in my 'Principles' and 'Elements.' When the Geological Society of France voted a sum of money to Archaic to draw up a report on the progress of geology for ten years (1835 to 1845, I believe), he wrote to me to say that all treatises on geology were left out of such reports, as they were presumed to be compilations, authors taking care to take date for their discoveries in scientific journals, but as my book was an exception to such rules, he wished me to send him an exact list of all my original theories and facts, and their dates, which, owing to their numerous editions, no one could make out, and which he must neglect without such aid" (vol ii. p. 107).

Among the new observations and generalisations to which Lyell may justly lay claim, we will here allude to one only. Before the appearance of the "Principles of Geology" no serious attempt had been made to bring into correlation those important deposits which overlie the chalk, which the labours of the Italian and French naturalists had invested with so much interest. William Smith's classification of strata, which had met with very general acceptance, both in England and on the Continent, dealt with the formation from the Carboniferous to the Cretaceous inclusive. But above and below those limits the greatest confusion and doubt existed in connection with all questions of geological classification.

What Sedgwick, Murchison, and Lonsdale did for the pre-Carboniferous rocks, Lyell accomplished single-handed for the post-Cretaceous; and his classification, though the advance of knowledge has necessitated modifications in it, is at the present day universally accepted so far as its main features are concerned. The amount of work undertaken by Lyell in collecting the facts upon which this Tertiary Classification is based was enormous, and is well set forth in the volumes before us (vol. i. pp. 182–319).

Besides the "Principles of Geology" and the expansions of the last part of that work, published under the successive titles of "The Elements of Geology," "A Manual of Geology," and "The Student's Elements of Geology," Lyell wrote four volumes of "Travels in North America," teeming with original facts and observations, and his "Antiquity of Man," or as the *Saturday Review* called it, "Lyell's Trilogy on the Antiquity of Man, Ice, and Darwin." And in addition to these separate works nearly seventy original memoirs contributed to scientific journals are recorded in the list at the end of the work lying before us, besides reviews, lectures, and addresses.

In obtaining the materials for these multitudinous publications Lyell was a most indefatigable worker. Every year he spent a number of months in travelling over parts of Europe or his own country, examining for himself the districts of which he had to treat in his works. It was very characteristic of Lyell that, though willing to learn from the youngest of his contemporaries, he never took anything on trust where personal examination was possible; and it was rarely indeed that his acute powers of observation and logical mind failed to extend, improve and correct the results attained by previous workers in the same field. He visited North America four times, spending thirteen months on his first tour, and nine months on his second, and subsequently resided for some months at Madeira.

But it is not only on account of the record which they contain of Lyell's own work, that the volumes before us are of such great value. Lyell was an active participator in all the scientific movements of his day, and his account of the meetings of the Geological Society, with its stormy debates, of the Geological Club and its convivial gatherings, of the Royal Society and the British Association, are full of the most lively and interesting details. Concerning a debate at the Geological Society in 1829 he writes to Mantell:—

"The last discharge of Conybeare's artillery, served by the great Oxford engineer against the Fluvialists, as they are pleased to term us, drew upon them on Friday a sharp volley of musketry from all sides, and such a broadside at the *finale* from Sedgwick, as was enough to sink the 'Reliquiæ Diluvianæ' for ever, and make the second volume shy of venturing out to sea. After the memoir on the importance of all rivers which feed the 'main river of an isle,' and the sluggishness of Father Thames himself 'scarce able to move a pin's head,' a notice of Cully, land-surveyor, was read on the prodigious force of a Cheviot stream, 'the College,' which has swept away a bridge and annually buries large tracts under gravel. Buckland then jumped up, like a counsel, said Fitton to me, *who had come down special.*"

"After his reiteration of Conybeare's arguments, Fitton made a somewhat laboured speech. I followed, and then Sedgwick, who decided on four or *more* deluges, and said the simultaneousness was disproved for ever, &c., and declared that on the nature of such floods we should at present 'doubt and not dogmatise.' A good meeting" (vol. i. p. 253).

Here is his account of the anniversary meeting of the Geological Society in the same year:—

"Sedgwick quite astonished them, it seems, in the chair at the general meeting, which was very full. Among innumerable good hits, when proposing the toast of the Astronomical Society, and Herschel, their president, he said, alluding to H.'s intended marriage (for he is just about to marry the daughter of a Scotch clergyman),

[1] Continued from p 148.

'May the house of Herschel be perpetuated and, like the Cassinis, be illustrious astronomers for three generations. May all the constellations wait upon him! may Virgo go before, and Gemini follow after!' Poor H., notwithstanding his confusion, got up after a roar of laughter had continued for three minutes, and made a famous speech" (vol. i. 251).

In the whole of these letters of Lyell there is a striking absence of anything like jealousy or ill-nature in his remarks. His judgment concerning his contemporaries, whom he had the greatest facilities for knowing, appears to be remarkably just and such as will, we believe, be endorsed by posterity. Take for example what he says concerning the great rivals Murchison and Sedgwick:—

Murchison "has a little too much of what Mathews used to ridicule in his slang as 'the keep-moving, go-if-it-kill-you' system, and I had to fight sometimes for the sake of geology, as his wife had for her strength, to make him proceed with somewhat less precipitation" (vol. i. p. 107).

"Murchison is one who has worked at science chiefly for the rewards, but not entirely, for if he had had no pleasure in it he would have failed; Sedgwick and Conybeare for the pleasure chiefly. What I shall always cherish, is a love for science, rather than its rewards; but I indulge the hope of profit, as the best earnest of usefulness, and also against its becoming a duty to accept some offer of an uncongenial situation" (vol. i. p. 373).

"Sedgwick asked me to walk home with him. I found a gloom upon him, unusual and marked. I most carefully avoided all allusion to the rejected living, but now when the first excitement of declining the boon is over, and that others have expressed their wonder at it, and that he finds himself left alone with his glory, he is dejected. He told me, Thursday last, that he wished before he left Cambridge, to *do something*. 'Now if I take a living instead of going to Wales, I abandon my professorship, and cannot get out the volume on the primary rocks with Conybeare,' &c. Then he hinted that in a year, when this is done, he may retire on some living, and *marry*. But I know Sedgwick well enough to feel sure that the work won't be done in a year, nor perhaps in two; and then a living, &c., won't be just ready, and he is growing older. He has not the application necessary to make his splendid abilities tell in a work. Besides every one leads him astray. A man should have some severity of character, and be able to refuse invitations, &c. The fact is, to become great in science, a man must be nearly as devoted as a lawyer, and must have more than mere talent" (vol. i. p. 375).

With respect to the unfortunate quarrel between these two pioneers in the study of the older palæozoic rocks, the line which Lyell adopts appears to us to be singularly just and judicious. He could not but see that Sedgwick's wrongs, like his maladies, were to a great extent imaginary, and, doing so, was filled with regret at the folly which made so able a man nurse his mortification and rage till it embittered the whole of his subsequent life. Writing in 1855 Lyell says:—

"In Phillips's new edition of his 'Geology,' just out, he makes the Lingula beds Cambrian, just as I do, which I am glad of, as however Murchison may complain, it is really we that are adhering to the original divisions and names adopted by Murchison and Sedgwick. It would be wrong to give up the term Cambrian just when we are beginning to have a distinct fauna for it, as Salter was the first to show here, and Barrande in Bohemia. Sedgwick's attempt to take the Lower Silurian into his Cambrian is even worse than Murchison claiming all that is older than the Devonian as appertaining to his Silurian" (vol. ii. p. 205-6).

Lyell had great opportunities of knowing Cuvier, and we cannot refrain from quoting what he tells us about the great naturalist's method of organising his work:—

"I got into Cuvier's *sanctum sanctorum* yesterday, and it is truly characteristic of the man. In every part it displays that extraordinary power of methodising which is the grand secret of the prodigious feats which he performs annually without appearing to give himself the least trouble. But before I introduce you to this study, I should tell you that there is first the Museum of Natural History opposite his house, and admirably arranged by himself, then the Anatomy Museum connected with his dwelling. In the latter is a library disposed in a suite of rooms, each containing works on one subject. There is one where there are all the works on ornithology, in another room all on ichthyology, in another osteology, in another *law* books! &c., &c. When he is engaged in such works as require continual reference to a variety of authors, he has a stove shifted into one of these rooms, in which everything on that subject is systematically arranged, so that in the same work he often takes the round of many apartments. But the ordinary studio contains no bookshelves. It is a longish room comfortably furnished, lighted from above, and furnished with eleven desks to stand to, and two low tables, like a public office for so many clerks. But all is for the one man, who multiplies himself as author, and admitting no one into this room, moves as he finds necessary, or as fancy inclines him, from one occupation to another. Each desk is furnished with a complete establishment of inkstand, pens, &c., pins to pin MSS. together, the works immediately in reading and the MS. in hand, and in shelves behind all the MS. of the same work. There is a separate bell to several desks. The *collaborateurs* are not numerous, but always chosen well. They save him every mechanical labour, find references, &c., are rarely admitted to the study, receive orders, and speak not."

"Brongniart, who, in imitation of Cuvier has many clerks and collaborateurs, is known to lose more time in organising this auxiliary force than he gains by their work, but this is never the case with Cuvier. When I went to get Mantell's casts I found that the man who made moulds, and the painter of them, had distinct apartments, so that there was no confusion, and the despatch with which all was executed was admirable. It cost Cuvier a word only" (vol. i. p. 249).

Although Lyell devoted all his energies to the advancement of geological science, and, as his letters show, steadfastly refused all honours and engagements which would interfere with the performance of the great tasks he had set before himself, yet he was far from being a recluse or one refusing to take an interest in the affairs of the time. His earliest essays in the *Quarterly* were employed in the advocacy of the importance of giving scientific instruction in schools and universities. In his "Travels in North America" he devoted a chapter to the subject of University Reform, and his remarks produced a great impression at the time, and before the Public Schools Commission he gave important evidence. In the reform of the Royal Society he was one of the most active members, and in many of the great movements of the day we find him playing the part of an earnest and advanced liberal.

On other than scientific subjects we may not stay to speak here, but we cannot refrain from mentioning that Lyell's works on America did much to dispel among the educated classes, on both sides of the Atlantic, the feeling

of irritation which had been aroused by the publication of the caricatures in Dickens' "American Notes" and "Martin Chuzzlewit." Non-scientific readers, too, will find much to interest them in these volumes, in the conversations and anecdotes of such men as Scott, Lockhart, Rogers, Whewell, Babbage, Macaulay, Sidney Smith, Milman, and many other eminent men with whom Lyell was on terms of close intimacy. The literary gossip is indeed scarcely less interesting than the scientific.

Of Lyell's amiable and gentle nature these letters and journals afford abundant and interesting evidence. His correspondence with his wife and sisters, and his little nephew, abound with illustrations of the beautiful traits of his character; and the warmth of his attachment comes out very strikingly in his communications with Mantell, Fleming, Horner, Darwin, and others, with whom he was in constant and friendly intercourse. His greatest weakness was perhaps the excessive caution, sometimes approaching timidity, which is exemplified very strikingly in his correspondence with Darwin and Hooker in vol. ii. pp. 361-366. But it must be remembered that it was this same cautious habit which first enabled him to gain the public ear, when it was but little disposed to attend to the teachings of science, and his reputation for this character gave to his later writings on scientific questions an authority which perhaps no other living writer could command. It was in consequence perhaps of this that Lyell's opinions on the subject of evolution, as stated in the "Antiquity of Man," were received by the public like the summing up of a judge, rather than as the speech of an advocate.

We cannot better conclude this notice of Lyell than by quoting the words of his friend the late Dean Stanley, on the occasion of the funeral sermon in Westminster Abbey:—

"Of him who is thus laid to rest, if of any one of our time, it may be said that he followed truth with a zeal as sanctified as ever fired the soul of a missionary, and with a humility as child-like as ever subdued the mind of a simple scholar. For discovering, confirming, or rectifying his conclusions, there was no journey too distant to undertake. Never did he think of his own fame or name in comparison with the scientific results which he sought to establish. From early youth to extreme old age it was to him a solemn religious duty to be incessantly learning, constantly growing, fearlessly correcting his own mistakes, always ready to receive and reproduce from others that which he had not in himself. Science and religion for him were not only not divorced, but were one and indivisible."

These words were spoken when the grave had but just closed over Lyell's mortal remains, but in the hearts of many who had the happiness of knowing and loving him, his memory will long continue green.

JOHN W. JUDD

OUR BOOK SHELF

A Treatise on the Diseases of the Nervous System. By James Ross, M.D. Two Vols. (London: Churchill and Co., 1881.)

THIS is a complete treatise on Diseases of the Nervous System, illustrated with lithographs, photographs, and many woodcuts, of which the latter have mostly been borrowed from several well-known anatomical and physiological works. The book is in many respects a valuable one, though in others it is not altogether satisfactory. The author is thoroughly accomplished in all that concerns the anatomy and physiology of the nervous system, and he is evidently fully impressed with the absolute importance of an adequate attention to details of this kind on the part of those who would master or keep themselves abreast of modern knowledge concerning disease of the nervous system. A vast amount of work has been done in strengthening our knowledge in this direction during recent years, and as a consequence in no department of medicine have greater advances in the direction of precision of diagnosis been arrived at. In no other work are these anatomical and physiological data, on which the practitioner must largely depend, so copiously reproduced. In this direction, indeed, there is some redundancy. Some of the chapters (such as Chap. I. of Vol. I.) might with advantage have been omitted altogether from the present work, whilst others (such as Chap. I. of Vol. II.), dealing with the Anatomy and Development of the Spinal Cord, might have been very considerably curtailed. An anatomical treatise is one thing, but a work on a department of practical medicine is another thing altogether, although in it many anatomical references ought to exist. On the physiological and pathlogical sides, what the author has to say concerning Inhibitory Functions generally, and concerning "Synkinesis" (or the pathology of Associated Movements), will be found to be both judicious and more or less original. But in studying the author's account of the special diseases of the nervous system, especially in the light of other previous and fuller disquisitions, one cannot help seeing that much of the work (as in the section on Paralysis of the Facial Nerve, for instance) partakes of the nature of careful compilation, and is defective in evidence that the author himself has had any very large experience of the diseases concerning which he treats. Some of the special diseases are indeed altogether inadequately discussed, considering the style of the work generally. In fine, this treatise, though not without considerable merits, is unequal and in many places over-diffuse in its treatment of different parts of the subject. Greater strength and evidence of a larger practical experience in dealing with the different nervous diseases would have made the book more evenly balanced, and caused the reader to think less of its redundancies. These blemishes might perhaps be rectified in a subsequent edition. At present it is a work which will probably possess more interest for the few who are already conversant with nervous diseases, than for the many medical men and students who desire to make themselves more acquainted with them. To the latter its bulk (about 1600 pages) will probably be alarming. The book ends with that most commendable thing, a good index.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Function of the Ears, or the Perception of Direction

REFERRING to the letter in NATURE (vol. xxv. p. 124) I may add that M. Buhler, our French landscape gardener, judges nicely the direction of sound. Some years ago I requested him to trace a walk across a wood so undergrown with a creeping plant that it was impossible to cross it. Having fixed the entrance and exit by going round the wood, he told my negro servant to answer every call of his by a shout. It just then occurred to me that an experiment might be made; and I ordered the negro (in his own language) not to shout, but to

whistle. As the ground was sloping, the walk was to be a curve; and Buhler, with little hesitation, pointed out the places where pegs should be laid by a man who opened a narrow path with a hatchet. Buhler did not retrace his steps, and left my grounds after saying that he had pegged the right side of a walk three metres broad. He then complained of the difficulty he had experienced because *that stupid darkie* had whistled in place of shouting. When the ground was cleared a few days afterwards, I found the curve even and seemingly faultless. When listening to each whistle Buhler turned his face, not towards it, but in the direction of the curve which must ultimately meet it. Have not English landscape gardeners the same faculty of judging rightly direction by sound ANTOINE D'ABBADIE

Abbadia, Hendaye, December 11

Dante and the Southern Cross

THE question "where Dante could have learned about this constellation" (*ante*, p. 152) has been discussed by most modern commentators on the passage referred to. The general conclusion arrived at seems to be that it was through the delineation of the "quattro stelle" on Arabian celestial globes. The best scientific discussion of the question will be found in Humboldt's *Kosmos* ii. 205, 6 (ed. 1870). Might not, however, the line "Non viste mai fuor ch' alla prima gente" suggest that Dante's knowledge was derived from some record or tradition, of the visibility of these and other southern stars to the inhabitants of the Mediterranean shores before the precession of the equinoxes carried them below their horizon? "Prima gente"—generally rendered "our first parents"—recalls irresistibly Horace's "prisca gens mortalium." J. J. WALKER

University Hall, December 18

YOUR correspondent who inquires whence Dante obtained his knowledge of the existence of the Southern Cross may be referred to Humboldt's travels for one explanation of this remarkable fact. I apprehend your correspondent alludes to the lines—

"To the right hand I turn'd and fix'd my mind
On the other pole attentive, where I saw
Four stars ne'er seen before save by the ken
Of our first parents. Heaven of their rays
Seem'd joyous. Oh thou northern site! bereft
Indeed, and widow'd, since of these deprived."

Dr. Barlow, the commentator of Dante, accepts Humboldt's explanation, and says: "The principal stars of this constellation were known when Dante wrote, and in the description here given there is a reality attested by all who have seen them. They were once visible in our northern hemisphere." Alexander von Humboldt, from whose philosophic soul the poetry of nature was never absent, says of them:—"In consequence of the precession of the equinoxes, the starry heavens are continually changing their aspect from every portion of the earth's surface. The early races of mankind beheld in the far north the glorious constellations of the southern hemisphere rise before them, which, after remaining long invisible, will again appear in these latitudes after a lapse of thousands of years. The Southern Cross began to be invisible in 53° 30′ north latitude, 2900 years before our era, since, according to Galle, this constellation might previously have reached an altitude of more than 10°. When it disappeared from the horizon of the countries of the Baltic the great pyramid of Cheops had already been erected more than 500 years." Barlow therefore infers with Humboldt that Dante knew of the Southern Cross by tradition, and adds that the words our "first parents" do not refer to Adam and Eve, but to the early races which inhabited Europe and Asia.

Grosvenor Street SAMUEL WILKS

Helophyton Williamsonis

I AM sorry to see that I have overlooked two mistakes in my brief note which you published in your last number (p. 124). In the fifth line *Hymenophylloides* should have been *Myriophylloides*; and lower down Urrger should of course be Unger.

WM. C. WILLIAMSON

Victoria University, Manchester, December 9

A Smokeless London

IT is not very improbable that we shall in a few years be indebted to the electric light for our source of nightly illumination. Before such an eventuality it would be interesting to know if there are any serious objections to employing hydrogen gas as our heating agent. Smokeless and innocuous in combustion, it would relieve us from many ills under which we labour now. When it was tried—after impregnation with a hydrocarbon—as a lighting agent (at Chichester, I believe) some years ago, it was found wanting, but there was no difficulty, I think, experienced in producing it cheaply from the decomposition of water and in sending it through the mains. No notice, I believe, has been directed to this at the Smoke Abatement Exhibition. Will you kindly raise the issue, and let us know the advantage or disadvantage of the project? EDMUND MCCLURE

1, Onslow Place, S.W., December 16

Meteors

ON the evening of Wednesday, November 16, whilst sweeping the western heavens in search of comets, I was startled by a brilliant illumination to my right. Looking up hastily, a bright meteor was seen moving rapidly in the north-eastern heavens; it started about 3° north of Capella, and traversed a path of some 10° in a north-easterly direction, passing about 2° above (or west of) δ Aurigæ. Its flight did not exceed three seconds, when it burst with a dazzling brilliancy to be compared only to the whiteness of the electric light. At the moment of bursting, it must have been at least five or six times as bright as Venus at her maximum. It left in its wake, covering the full length of its path, a thin, reddish train, which drifted slowly toward the north-east among the stars, gradually collecting into a lightish cloud at its north-east end. Noting the remarkable permanency of the train, I turned the telescope (a 5 inch refractor) upon it, and was surprised to see a brightly-glowing mass of pinkish smoke. The same matter was stretched out toward the south-east into a long, straggling strip. This trail was about ½° in breadth, and could be plainly seen with the telescope for a distance of at least 10°. The whole of this drifted north-easterly over the stars, curling slowly like a mighty serpent; it was knotted in places with cumulus forms, probably due to minor explosions in the meteor. The outlines of this wonderful train of celestial smoke were well defined; it did not diffuse itself into the atmosphere, but gradually faded, becoming more contorted each moment. During the whole time of its visibility it retained its pinkish colour. The first appearance of the meteor was at 6h. 48m. local time; the train remained visible to the naked eye for about six minutes. In the telescope it was distinct up to seven o'clock, and at 7h. 03m. it could still be seen in the instrument. While visible, it drifted about 4° to the north-east. No explosion was heard, though listened for. Latitude of place of observation, 36° 10′ north; longitude west of Greenwich, 86° 49′. E. E. BARNARD

Nashville, Tennessee, U.S.A., November 27

ON Wednesday, December 14, at 10.30 p.m., I saw a very brilliant meteor. It appeared to start from the barren region of the Lynx, bordering on the Twins, a little to the east, and above Pollux, and travelled in the direction of Canis Minor. It was much brighter than any object then shining, though Jupiter and Sirius were both visible, and left a train of light behind which appeared to be granular, of a dull red colour, and fusiform in shape. I did not see the meteor through its entire path, on account of a house intervening, but the train of light behind it was not visible at the commencement of its path, and appeared to terminate before the disappearance of the meteor. This was by far the brightest meteor I ever saw. The same evening and the week previously I saw many meteors in the region of Aries, but none very brilliant. E. HOWARTH

Sheffield Museum and Observatory, December 18

Herbaceous Stem on a Palæolithic Implement

INSTANCES are so extremely rare where vegetable material (as old as the drift gravels) is found adherent to drift implements, that the following instance is probably worthy of note:—Amongst my collection of Palæolithic implements from the neighbourhood of Bedford, I have one *perfectly unabraded* example—bright ochreous yellow in colour from its long deposition in the drift. Near the middle of the implement there are the remains of some herbaceous stem firmly fixed to the flint; the colour of the vegetable material is bright ochreous, and under the microscope the vegetable structure (especially the vessels) is most clearly

seen; the patch is an inch long and about a quarter of an inch in average width; it has not the stellate cells of the rush. The material has been protected in a depression in one of the artificial facets of the implement, and in a second position somewhat nearer the butt, there is further trace of the same material. My opinion is that these grass stems (or whatever stems they may be) were possibly wrapped round the basal end of the implement as a protection for the hand against the asperities of the flint. The asperities are very noticeable in the instrument referred to, as it has a sharp cutting edge at the butt, with none of the original bark of the flint left for convenience of holding. The vegetable material is undoubtedly as old as the implement, and the unabraded condition of the stone may account for its position in the facets. WORTHINGTON G. SMITH

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Awned Carpels of Erodium

SIR JOHN LUBBOCK's address to the British Association, and Mr. Francis Darwin's paper in the Linnean *Transactions*, on the hygrometric awns of the achenes of *Erodium* and other plants, fail to give the honour to the right man. Their references reach some thirteen years back; but if they will look further they will find the late discoveries (including those of Hildebrand and Zimmerman in *Pringsheim's Jahrbücher*) forestalled as to *Erodium* by nearly half a century. In the *Magazine of Natural History* for 1836 is a modest contribution of nearly two pages from Robert Mallet of Capell Street, Dublin, describing and figuring his observations on the achenial awns of *Erodium moschatum* and *Pelargonium peltatum*. He finds that the awns of *Erodium* possess "most wonderful hygrometric sensibility." The five awns lie in grooves of the carpophore. He gives transverse views of the awns in various conditions of torsion, and of the carpophore (not as well executed as the similar ones of F. Darwin and Hildebrand). He states that aridity causes the awns to twist, and so to extricate themselves from their grooves, and at the same time downy filaments bristle forth from the awns, and the achenes detach themselves and fall to the ground. Here the awns still continue to twist and keep tumbling over, so as to recede from the parent plant. At last by twisting they become like balloons wafted about by every zephyr. But motive power has not ceased with the awn: the slighest hygrometric change produces motion either backwards or forwards in it; and the constant tendency of this motion is to *screw the seed into the ground* (Mr. Mallet's italics). Such is the shape and great sensibility of the awns, that they may be readily applied to form most delicate hygrometers, for which purpose he had used them. Nearly all of these observations have been rediscovered and confirmed and published in elaborate form by the eminent investigators of our own day.

Princeton College, November 15 G. MACLOSKIE

The Song of the Lizard

WHILST quartered in St. Helena, at Ladder Hill, I was frequently disturbed by the "*tweet-tweet*" of a small lizard in the verandah and Melia trees which overshadowed it, which sounds for a long time I thought were produced by birds. It is, according to Melliss' description, the "*Hemidactylus frenatus* (Schleg.).—A small brown harmless lizard about four inches in length, which lives under stones and old timber in the warm lower parts of the island. It seldom enters houses unless in pursuit of flies or scorpions, but is plentiful about the neighbourhood of Jamestown, where in the evening its loud chirp is frequently heard." This may corroborate Mr. Pascoe's remarks in his letter to NATURE (vol. xxv. p. 32). S. P. OLIVER

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A Double Egg

I HAVE received a very remarkable egg, or rather, I should say, a double egg, laid by a hen belonging to Mr. Isaac Sharman, of Kanmoor, Sheffield. The egg weighed 4¾ oz., and measured round its greatest circumference 8 inches, and its least 7 inches. In measuring the egg the shell was broken, and inside the outer shell there was no yoke but simply white of egg surrounding another perfect egg of the average size. This inner egg has the shell quite complete and hard. Mr. Sharman describes the bird as a cuckoo hen. E. HOWARTH

Sheffield Public Museum, December 12

SIR ANTONIO BRADY

IT is always with a keen feeling of regret that we record the loss from the scientific ranks of men whose faces, as well as their names, were familiar to us by long association, and who were for years fellow-workers in the same geological area. Such a one was Sir Antonio Brady, F.G.S., who passed from among us on the 12th inst. from an affection of the heart.

He was the eldest son of the late Mr. Anthony Brady, of the Royal William Victualling Yard, Plymouth, by his marriage with Marianne, daughter of Mr. Francis Perigal. Born in 1811 he entered the Civil Service of the Navy as a junior clerk in the Victualling Yard, Deptford, more than fifty years since. After serving in various offices, having been promoted to head-quarters, he became head of the Contract Office and Registrar of Public Securities in 1854, subsequently assisting to reorganise that office. After the reorganisation of the office he was appointed first superintendent of the Purchase and Contract Department, retiring from the service in 1870, when he received the honour of knighthood. Since his retirement from the public service, Sir Antonio has devoted his energies to the service of the public, and having taken a leading part in the preservation of Epping Forest for the people, was appointed a judge in the "Verderer's Court for the Forest of Epping." He also took great interest in the work of church extension, and was a member of the Ray, the Palæontographical and Geological Societies; he was also in the Commission of the Peace for Westminster. The deceased married, in 1837, Maria, eldest daughter of the late Mr. George Kelner, of Ipswich, by whom he leaves a son, the Rev. Nicholas Brady, M.A., and two daughters.

But it is in his character of a geologist that we must now speak of Sir Antonio Brady. So long ago as 1844 his attention was attracted to the wonderful deposits of brickearth which occupy the Valley of the Roding at Ilford, within a mile of his residence. Encouraged by Prof. Owen and other eminent palæontologists, he commenced to collect the rich series of mammalian remains which the Thames Valley brickearths yield. Owing, however, to their porous nature, the bones had lost, during their long interment, all their gelatine, and the earlier "finds," when exhumed, were so soft and friable that they crumbled beneath the touch, and it was not until fresh gelatine had been introduced that it was found possible to preserve these magnificent remains of the old inhabitants of this district. In his Catalogue of the Pleistocene Mammalia from Ilford, Essex (1874, 4to, printed for private circulation only) Sir Antonio Brady pays a just tribute of respect to the genius and ability of his first instructor in the art of preserving fossil bones, and acknowledges that he was indebted to Mr. William Davies, F.G.S., of the British Museum, for the preservation of most of the larger specimens in his collection.

Some idea may be formed of the enormous riches of this deposit when we find that an amateur, in his leisure hours, was able to amass nearly one thousand specimens of Mammalia from a single locality, comprising: *Felis spelæa*, *Canis vulpes*, *Ursus*, sp., *Elephas primigenius*, *E. antiquus*, *Rhinoceros leptorhinus*, *R. megarhinus*, *R. tichorhinus*, *Equus fossilis*, *Megaceros Hibernicus*, *Cervus elaphus*; *C.* sp.; *Bison priscus*; *Bos giganteus*, *Hippopotamus*, sp. To this interesting series of fossil remains of the old fauna of the Thames Valley, we may add that the subsequent researches of Prof. Boyd Dawkins, F.R.S., and R. W. Cheadle, Esq., F.G.S., have added the "Musk ox," *Ovibos Moschatus*, and the labours of F. C. J. Spurrell, Esq., F.G.S., the "Lemming." We have thus presented to us in this area the conjunction of the Northern and Southern forms of land-animals as marvellous as that which modern London exhibits to-day, in its assemblage of specimens of the genus Homo, from

every clime. For with the *Hippopotamus*, the *Rhinoceros*, and the Lion from the south, we have also in abundance the *Cyræna fluminalis*, a shell now characteristic of the Valley of the Nile and the rivers of India and China: whilst from the north advance to meet them the "Musk-Ox," the Reindeer, and the Lemming; we have also evidence at Walthamstow of the Elk (*Alces malchis*).

To Sir Antonio Brady, then, we are indebted for a most valuable collection of Pleistocene mammalia, now happily preserved in the British Museum of Natural History, Cromwell Road. Nor must we omit to mention that he strove by his presence, as a resident at Stratford, and by his constant acts of kindness and hospitality to the workmen, and by the *largesse* which he freely gave, to rescue from destruction these intere ting relics of a pre-historic age, which now help to swell the magnificent series of our National Museum.

HENRY WOODWARD

BRIGHTON HEALTH CONGRESS

THE Brighton Health Congress, which was opened on Tuesday, December 13, and which has been accompanied by an Exhibition of Domestic, Sanitary, and Scientific Appliances, has been one of the most successful of its kind, and by far the most successful of any of a purely local character. In origin and in progress it has, throughout, been Brightonian, and although many of the scholars who communicated addresses and papers were outsiders, they came by invitation. To the Congress in the course of the week no less number than 1200 added their names as Associates, while the Exhibition was at all times well filled, some 400 persons per day, independently of the Associates, paying for admission. It is estimated, indeed, that altogether between four and five thousand persons have been present. We stated last week that the Exhibition was presided over by Lord Chichester, and the Congress by Dr. Richardson; and we gave a detail of the sections and order of proceedings: we shall dwell more particularly on the addresses and papers which were submitted.

The President's Opening Address

Dr. Richardson took for his theme "The Seed-Time of Health." In the opening passages he drew a picture of life and death in the time when the ancient Greeks were in the meridian of their intellectual existence. In the midst of the night, when the sun cannot see the deeds of men, certain of these were depicted carrying a dead child, in all its beauty, to the pyre. They carried it in this solemn silence and darkness because of the shame they felt that anything so young and beautiful should die in what ought to be the seed-time of health. Upon this he drew a sharp and striking contrast from our own time. He pointed out the great mortality of our children, for which we have grief, fond memories, but no shame. We accept the events, in short, as if they were natural, and erect memorials of them.] After illustrating these points, the causes of the great mortality of the young were classified under four heads—the inherited, the accidental, the inflicted, and the acquired. Under the first head the influence of hereditary diseases were discussed; under the second head the diseases of an epidemic character, and which occur from exposure to one or other of the communicable poisons, were considered; under the third head the injuries arising from bad nursing, excessive competition in education, and improper feeding, were brought under notice; and under the fourth head the evils incident to early resort to smoking, the use of stimulants, late hours, and irregular meals, were made subjects of comment. What now is wanted, said the President, was the ideal of a new nobility. In the wild-boar days of human existence; in days when men, hardly emancipated from lower forms of life, crept out of their caves, their huts, their walled prisons, to see their nobler species go forth to exercise those rude arts of hunting, fighting, revelling, which formed the whole art of civilisation, there was a nobility which deserved the name—the representative of necessity. But now, when these arts have degenerated into mere childish imitations, mere apedoms of the great past, they are but injurious pretensions for nobility of soul and body. Once noble, according to the spirit of their day they are in this day ignoble. The address concluded with two applications of thought, one general, the other local. The general requested those who rule and govern us to look at the seed-time of health as it is, and take it as the test of good or bad government. The local was addressed to the people of Brighton, that the meeting then commencing might be truly useful, and the date from whence they should move onwards until the shame of mortal events, which the sun should never witness, be felt whenever they occur.

Section A.—Health of Towns

The president, Mr. Edwin Chadwick, C.B., opened the Section on Wednesday with an address on the prevention of epidemics. He set out by describing the various means adopted to stay the great outbreak of cholera in 1848, in which he took a prominent part, and the deductions made from observations then taken. The conclusions that had been come to then were that to aggregate disease in large hospitals was only to increase the danger, and that the very best means of preventing the spread of infection was by the adoption of sanitary measures at the places where, in the cycle of epidemics, they were to be expected. He described in a very interesting manner the precautions taken at York, at Merthyr Tydvil, at Mevagissy in Cornwall, and other places, and the gradual decrease of deaths that followed, and he showed that similar precautions taken at St. Petersburg, Malta, and Memphis, had had the same result. At St. Petersburg, for example, the deaths had decreased from 25,000 to 3000 in the successive decade. Some other equally startling statistics were given by Mr. Chadwick. By the returns of the Local Government Board, he calculated that we had saved in the death-rate from disease or infection a quarter of a million of lives, and three million cases of sickness, and putting this at a money value, 5*l.* for death and 1*l.* for a sickness, over four millions of money had been saved. In conclusion he portrayed with poetical picturesqueness a possible future "when medical science shall occupy itself rather with the prevention of maladies than their cure, when governments shall be induced to consider the preservation of a nation's health as important as the promotion of its commerce or the maintenance of its conquests, and when we may hope to see approach a time in which, after a life spent almost without sickness, we shall close the term of an unharassed existence by a peaceful Euthanasia."

The papers which followed the delivery of Mr. Chadwick's address were all of them good, and some of them of unusual excellence. Mr. Easton's account of the water supply of Brighton was exceedingly interesting and able. It led to a sharp and animated debate on the water softening process in large towns. Mr. Easton and the Mayor, while advocating the principle of softening water, seemed inclined rather to look upon it as a household than a municipal duty. They were opposed by several other speakers. Mr. Griffiths followed with a paper on the escape of foul gases from ventilating gratings on the main sewers of towns. The gist of his argument was that the faults were rather in the houses than in the sewers. If, he maintained, the sewer system of houses was so perfect that nothing could be retained in the sewer pipes, and if the houses were thoroughly cut off from the sewer, the risks of escape of gas were greatly reduced. What was wanted in the sewer was a current of air, not ventilation at one point. The defective house drainage

throughout the country was the evil that required the most speedy rectification.

Dr. Mackay supplied an excellent paper on the geology and climate of Brighton in relation to health. He gave many details, and finally came to the conclusion that the general view was correct, that autumn was the best season for Brighton. The freshness and coolness of the town in the early summer ought also to be remembered.

Dr. Fussell pleaded the necessity for recreation spaces in all large towns. He said there were about 100 towns in England containing upwards of 25,000 inhabitants, and that much of the decrepitude and high mortality amongst the young was caused by the excessive density of the populations.

Mr. Ellice Clark dwelt on the anomalies in the administration of the sanitary laws; and Dr. Browning read paper on the correlation of public health and sanitary legislation.

One of the most interesting essays read in this section was by Mr. Frederick Walsh, and was entitled "Sanitation in Japan, a Comparative Study." Mr. Walsh, who has resided long in Japan, detailed the diseases most prevalent there, together with an account of the mode of application of the sewage for agricultural purposes. He condemned very strongly the system of London drainage, and argued against the loss which was sustained in consequence of that system, contending that we had created by it most of the evils of which we complain.

The last paper read in this section was by Mr. H. F. Lester, on "Reform in Slaughterhouses." The author described tersely the present condition of private slaughterhouses, and contended that the great reform required in them consisted in the erection of public *abattoirs* in all our large towns. The paper led to a brisk discussion, the general sentiment being in favour of the views expressed by the author. Owing to an accident of arrangement a paper by Mr. W. S. Mitchell, M.A., entitled "A Comparison of English and Foreign Watering Places," had to be taken as read.

Section B—Food in Relation to National and Domestic Economy

The president, Mr. J. R. Hollond, M.A. M.P., opened the Section on Thursday with an address on the subject of the "Production, Distribution, and Economic Use of Food." In considering the first head, he maintained that until the conditions under which the land was held were modified, and a much larger portion of the land brought up to the level of the best farming, it was premature to speak of the limit to the production of bread and meat having been nearly reached. He noticed the obstacles to agriculture in our land customs and the imposition of extraordinary tithe on market and hop gardens. Our landed system hampered the nominal owner in his power of dealing with his land; our system of transfer stood in the way of a ready change of ownership, and the cultivator had insufficient security for the capital he put into his business. Under the second head he said Free Trade for us was not only a benefit, but a necessity, and commented upon the way in which the English food-producer was hampered by the heavy carrying-rates of the railway companies, and advocated the market system of Paris. In treating of the economic uses of food he advocated the use of vegetables in greater variety, and in regard to alcoholic drinks, from the point of view of making the most of the means at command, thought the outlay on them might with advantage be made elsewhere. In conclusion he alluded to the unsatisfactory results of our cooking arrangements and the wastefulness entailed thereby. He expressed himself in favour of teaching cookery in schools in a systematic way.

Dr. C. B. Drysdale then read a paper on "Cheap Food and Longevity," and showed by the statistics of New Zealand that, while the other circumstances were not specially favourable, as against this country, there was a lower death-rate, calculated at 12 in 1000 annually, combined with great cheapness of food. He contended also that the comparative scarcity of food here was caused by the higher birth-rate, which should be publicly discouraged in all European states.

Mr. A. F. Halcombe read a paper of special excellence on "New Zealand as a Source of Food Supply," showing the great capacity of New Zealand for furnishing us with food, and the prospects ultimately of large supplies being obtained from this growing colony. The writer supported also the statements made by Dr. Drysdale as to the healthiness of the New Zealand Climate.

Miss Yates followed with a paper on Bread Reform. She especially recommended the use of wheatmeal bread. She urged the members to support this movement for the sake of the children who are ill-nourished from being fed on impoverished white bread.

Mr. T. B. Lightfoot, in a very lucid paper on the "Preservation of Food by Cold," detailed the various steps of the dry-air freezing process, and stated that there need be no further difficulty in supplying the demands of this country with wholesome fresh animal food if the matter be approached in a scientific and business-like spirit. His paper elicited from the President of the Congress the fact that he (the President) had seen the carcases unpacked from Australia, had examined the preserved flesh, had partaken of it, and had come to the conclusion that the scientific difficulties were solved, and that nothing but commercial cupidity at home stood in the way of abundant supply of cheap food for the working classes.

A paper by Mr. Wynter Blyth, on "Rational Feeding and Eclectic Dietetics"; another paper by Dr. Whittle, on "Artificial Dieting of Infants"; another by Mr. Cowan, "On Honey as an Article of Food"; and still another by Mr. Mitchell, on "Lessons on Foods," led up to a final address by Major Hallett, on "Food-Plant Improvement." In this paper Major Hallett described his remarkable experiments and successes in improving the growth of wheat and other cereals, together with his latest experiments upon the growth of the cotton-plant, all of which we must reserve for another and special occasion.

Evening Lecture—Propagation of Disease through Food and Drink, by R. P. B. Taafe, M.D., Medical Officer of Health for Brighton

Dr. Taafe's lecture was a very carefully prepared reading on the diseases of the body which are propagated through food and drink. He dealt first with the introduction of parasitic diseases in this way, next of the zymotic. He presented in a very clear manner the views of those who support what is called, commonly, the germ theory of disease. Finally he dwelt upon the subject of prevention, and at the conclusion of his lecture received a very hearty vote of thanks.

Section C—Domestic Health, including Educational Training

Dr. Alfred Carpenter on Friday delivered the presidential address on "Domestic Health." He dwelt upon the public indifference in regard to matters of health, and expressed his belief that there was a border-line between health and disease, in which the conditions necessary for the establishment of disease must have time to produce their results before the disease actually arose. Speaking of zymotic diseases, he urged that their very existence was an evidence that natural waste was retained somewhere in too close a proximity to particular persons who became subject to disease. He dealt with the error of sending wastes into sewers, and proceeded to show that these wastes as soon as they became such, changed their character unless properly and naturally dealt with by being given to the earth. The address was very warmly received.

The papers that followed were so numerous that

although the section sat until nearly six o'clock they could not all be read.

The first by the late Sir Antonio Brady on "Prevention of Smoke in Fire Places" was read by Gen. Alexander, one of the secretaries of this section.

Mr. H. H. Collins followed on "Home Sanitation and House Inspection," the practical common sense of which was that every man and woman should be their own sanitary inspector.

Mr. Burton, for Prof. Fleeming Jenkin, argued the importance of associations with an annual subscription, for sanitary inspection.

Dr. Strong, of Croydon, supplied various hints on domestic sanitation, supporting earnestly a constant instead of an intermittent water supply. Mr. Bailey Denton treated on the subject of the domestic filtration of water, giving a description of the common filters in use, with special reference to those in the exhibition. Mrs. King created a great interest by an essay on "Health in Relation to Clothing," in which she proposed a radical change for the better in the clothing of women. Mr. Alderman Hallett, Mayor of Brighton, described an every-day process for the domestic softening of water from the chalk, and illustrated his paper by one or two simple and very neat experiments.

Mr. Henry C. Stephens took up the subject of public elementary education in relation to public health, presenting an exceedingly thoughtful and practical communication, in which it was urged that in the beginning of life the senses should be more carefully trained by easy exercise of observation, analysis of impression, and muscular training in connection with mental effort.

The proceedings of the section were brought to a close by an address singularly felicitous in style and matter, by Major Robert Edis, F.S.A., on "Sanitation in Decoration."

General Meeting

At the conclusion of the sectional sitting which, like all the others, had been held in the Dome, the President took the chair for the general meeting, at which the usual formal votes of thanks were moved, seconded, and carried, together with the following resolution of condolence and sympathy: "That this meeting has heard with the deepest regret of the death of their much esteemed and distinguished colleague, the late Sir Antonio Brady, and hereby requests the President of the Congress to convey to Lady Brady and her family the sincere condolence of the members in an event which to them and the public is so great a bereavement." After the general meeting a large number of the Associates attended the "Health Congress Dinner" in the Banqueting Room of the Royal Pavilion.

Lecture to the Working Classes, by Brudenell Carter, F.R.C.S.

The proceedings of the Congress were brought to a fitting close on Saturday evening, Dec. 17, by the lecture delivered to the working classes, as well as to the Associates, by Mr. Brudenell Carter. The lecturer took for his topic "Eyesight," and for an hour and ten minutes held the large audience in closest attention. He first treated on the evolution of the eye as an optical instrument; next he described the structures of which the instrument is composed; thirdly, he discussed the irregularities of structure, dealing specially with the two irregularities, short sight and colour-blindness; lastly, he treated on the practical application of the knowledge of visual defects in its relation to educational training. The bad practice of teaching children to read and write with their eyes close to the paper, by which the defect of short-sightedness is so extensively produced, was strongly condemned, as well as the faults connected with bad light, bad paper, and irregular and imperfect printing.

The Exhibition

We should be remiss if we did not add a few lines on the Exhibition. The managers of this department struck out quite a new line in making it something more than sanitary. They called it a domestic, sanitary, and scientific exhibition, and this enabled them to introduce various things that add to the useful and the ornamental, as well as the healthful. All kinds of electrical apparatus that could serve in the house were shown. Various kinds of mechanical contrivances, and numerous objects for illustrating artistic improvements, such as painting of walls in corridors, halls, staircases, and rooms. Horological instruments found a place, and a great number of instruments for recording time were under constant inspection. In addition, the bicyclists and tricyclists had their department, and were presented with a goodly show of these new machines for pleasurable and useful exercise. In a word, all was so excellently classified, selected, and arranged that on the whole we never remember to have seen so good an exhibition. In the six visits we made to it we cannot express correctly which pleased us most, the place itself and its exhibits, or the extraordinary interest with which all the visitors, rich and poor alike, took in it. Everybody seemed to show an intelligent desire to collect all practical information that could be obtained; and when from this task they passed to the fine art Loan Collection which the authorities at South Kensington had the kindness and excellent taste to supply, the transition from the useful to the beautiful was indeed a pleasurable sight.

The peculiar feature of the Brighton Health Congress was its character as an example. In numbers and importance of papers read and discussed it rivalled some of the organised congresses, which having the metropolis as their centre, proceed to different towns and make them for a short season their platform. There can be no doubt that there is some danger to what are called the peripatetic societies in this initiation. If the town of Brighton can call together twelve hundred members to a congress, secure papers for various important sections, command the services of efficient officers, issue a volume of Transactions, and get together a scientific exhibition that shall attract several thousands of visitors, what may not larger towns accomplish, such as Birmingham, Manchester, Leeds, Newcastle, Liverpool, Edinburgh, and Glasgow. These immense places cannot possibly be expected to remain uninfluenced by the example set by Brighton and the results of the example. If then each town takes to forming its own congresses, there will soon be little ground left for congresses on the visit. Towns will vie with towns in organising instead of receiving meetings organised for them to receive. For our part, however, we augur nothing but good from such a new departure and new development. The light of science and knowledge will only burn all the brighter in a place out of which it has been struck; and as every town must invite to its congresses the same workers as would go if they followed the peripatetics, the characters of the different meetings will be the same in effect and usefulness.

ANCIENT TIDAL ACTION AND PLANES OF MARINE DENUDATION

THERE is at least one question in ancient physical geology on which the speculations of Prof. R. S. Ball (NATURE, vol. xxv. pp. 79, 103) regarding the magnitude of Tidal Waves in times past seem to throw fresh light, namely, the origin of "planes of marine denudation." For those readers of NATURE who may not be familiar with this term, first proposed by Prof. Sir A. Ramsay, let me endeavour briefly to describe them. If we protract to a true scale the outlines of certain tracts of the British Isles, of Europe, or of America, we shall find

that the higher portions of the ridges tend to rise to a certain level, which, on being connected by an imaginary plane, form a gently-sloping surface over a considerable area, it may be of hundreds or thousands of square miles in extent. Now, if in addition to this we insert the stratification of the district crossed by the section, and taken from actual observation, it will often be found that this imaginary plane is formed of the truncated edges of highly-inclined strata, or of the denuded summits of anticlinal arches of contorted or folded strata. When such strata are of hard and tough materials it is clear that they must have been planed down by an agent of great power and of long-continued action, but the result has been to convert originally highly uneven surfaces of flexured strata into approximately horizontal surfaces, over which inequalities have been worn off. Through such planes the existing river-valleys have been cut down, but between neighbouring valleys there is to be found the intervening ridge, trending upwards to the original, now imaginary plane. The Silurian district of Central Wales offers a remarkable example, which has been used by Prof. Ramsay ("Mem. Geol. Survey," vol. i.). Let any one on reaching the summit of one of the long ridges to the south of Cader Idris place his head on the ground, and in this position survey the tract of hilly country lying to the southwards, and he will realise the nature of the plane surface, out of which the valleys have been hollowed. But there are many more remarkable instances even than this. The central plain of Ireland is an example on a larger scale, over which the Middle and Upper Carboniferous rocks have been swept away, leaving a floor of limestone; but it would be impossible to explain the course of its great river, the Shannon, without referring its origin to a time when a sloping plain stretched from the present sources of that river amongst the Leitrim Hills to Shannon harbour below Limerick, because now its channel traverses a ridge of Old Silurian rocks at Killaloe, which could not have existed *as such* when the river first commenced to run over a tract formed of Carboniferous beds since denuded. But it is amongst mountainous districts that the evidence of the former existence of old planes is most remarkable, because least expected. The higher ridges of the Grampians seen at a distance, or accurately drawn from a hypothetical standpoint (as on Mr. Knipes' panoramic picture), forcibly bring home this idea to the mind. The ridges and peaks with very few exceptions tend to rise to an imaginary plane connecting the higher elevations, while several actual terraces coincide with the plane itself. Out of this old plane the existing valleys have been cut down, during the vast period of time descending from the pre-Devonian to the present. A still more ancient plane was that in which the Cambrian sandstones and conglomerates were strewn, formed of tough gneiss and hornblendic schists, with a gentle rise towards the east. The Scandinavian Promontory offers an illustration on a grand scale, and to these we might add the pre-Triassic plane formed of the denuded Devonian and Carboniferous rocks of Belgium and the Rhine highly tilted, convoluted, and contorted, through which the existing rivers have carved out their channels. But I refrain from adding additional illustrations, as I must pass to the consideration of the question, How have such ancient planes been formed? Where was the agent capable of abrading down hundreds or thousands of feet of the most obdurate rocks over hundreds or thousands of square miles, and of transporting power sufficient to carry away the *débris* of these vast ruins? The geologist answers, "Only give me an unlimited time, and the waves, tides, and currents of the seas acting along the coast-lines as they at present act, will effect all that you demand." Granted that with "unlimited" time all this may be effected, but this is a demand which the astronomers will not concede, and geologists must pay some respect to astronomers and mathematicians after all. But even with the aid of (practically) "unlimited" time a serious objection meets us at the threshold. It is undeniable that the crust of the earth is always on the move, either upwards or downwards; those who are not intensely uniformitarian in their views contend that this oscillatory motion of the crust was much more rapid in past geological times than at the present day. If this be admitted, and I hold that it is a necessary consequence of the constantly decreasing rapidity with which the secular cooling of the surface has progressed downwards to the present day, how, let me ask, are you to get the coast to remain sufficiently long within range of such wave action as we see at present, to admit of the abrasion of the land to any considerable distance. The effects of wave action along our existing coasts, where formed of the more solid strata, is admittedly very slow, and in order to produce any great planing effects, the same coast-level (approximately) must be presented to it for a lengthened period; but with the required (practically) "unlimited" time, the coast-level would be placed out of reach, either by elevation or submergence. The hypothesis of approximately unlimited time seems to me, therefore, to be untenable. And what *we require is not time but force*, in order to account for the planing away of vast masses of obdurate strata over extensive areas. Such additional force Prof. Ball has supplied us with. He has shown that at a comparatively early stage of geological history the tides may have had a denuding effect several hundred times more powerful than the present. With such a "stupendous tidal grinding-engine" we may indeed conceive the work we have to account for accomplished, and the hypothesis of Prof. Ball approaches certainty, when it is considered that the character of the floors of the sea adjoining our coastlines gives but slight evidence that such planes of marine denudation as I have attempted to describe, are in course of formation at the present day. They are phenomena of the past, not of the present, when wave and tidal action has, happily for mankind, subsided into restricted limits as compared with that of Palæozoic and Mesozoic times.

EDWARD HULL

TELEGRAPHS IN CHINA

ON December 2 a telegram was received from Reuter's agent at Shanghai, announcing that the telegraph line between that town and Tientsin was finished. In a few weeks we may expect to hear of the completion of the line to Peking. The capital of the Chinese empire, the chief seat of bigotry and hostility to foreign innovation, will then be in direct communication with Europe and America. There is, we believe, no doubt in the minds of those acquainted with the origin of this undertaking, that political motives alone dictated it. Hitherto, during the winter, when the mouth of the Peiho was closed by ice, couriers taking from twenty to thirty days on the journey travelled down the Grand Canal to the Yangtsze conveying letters to Shanghai; or they were sent across Manchuria, in from fifteen to twenty days to Kiachta, where they reached the Great Northern Telegraph Company's Siberian lines. These slow and uncertain modes of communication with the outer world were severely felt by the Chinese Government during the winters of 1879 and 1880, when its relations were almost broken off with Russia, when the land and sea forces of the latter were hanging like a thundercloud on the frontiers of China, and a peaceable solution of the Kuldja question seemed impossible. It was then brought home to the Peking authorities that their coasts might be invaded, their principal cities captured, and the foe be almost at their gates weeks before they heard the news. The bitter experience of these years taught the Chinese a hard lesson, but one which they speedily took to heart. Long before the Marquis Tsêng brought the question to a

peaceable conclusion the Chinese Government had ordered large quantities of telegraph material from England, and within a few months of the ratification of the treaty with Russia, we find the port of Peking connected by telegraph with the rest of the world. The Chinese may occasionally be slow in their mental processes, but the present instance shows that when once the utility of an innovation is clearly presented to their minds, they seize and assimilate it with a rapidity worthy of their more mercurial neighbours, the Japanese; and this, it will be observed, is as true of the Government as of individuals.

It is not yet known how far the new lines will be open for public use; but, judging by the rapid spread of other foreign inventions in China when once introduced, we cannot be far wrong in anticipating a vast extension of the telegraph for all purposes in that country. Ten or twelve years ago there was hardly a Chinese-owned steamer engaged on the coasts or inland waters of the empire; 84 per cent. of this trade is now carried on in Chinese bottoms. Large and well-appointed steamers, Chinese-owned and manned, now ply to every port along the coast and on the Yang-tsze. As we write, a Chinese steamer has arrived in the Thames, bringing several native merchants who are about to enter into competition with us on our own ground. From time to time we have recorded in NATURE the various stages in the progress of the new telegraph line, because it marks one of the most important steps that has ever been made in China towards the adoption of the results of Western science and civilisation. It is one of the very few improvements which she has adopted without external advice and pressure; in this instance she has sat at the feet of the best of all teachers, experience, and has profited by its precepts. Nor is the event any the less important when we reflect on the development possible for the other appliances of steam and electricity, now that the ice of dislike and distrust of innovation has been spontaneously broken. The intelligence and enterprise of the three hundred millions of the people of China will not long remain content with a single line of telegraph across a comparatively small corner of their vast territory. A race of men with strong mercantile instincts who seize with avidity on every time—or labour-saving appliance, the Chinese, now that their government has abandoned its most cherished prejudice, may well be expected to call for the extension of an invention such as the telegraph.

We may fitly conclude this attempt to forecast the future in China of one of the most remarkable productions of western science in the nineteenth century, by mentioning the lesson which may well be derived from our past intercourse with that country. It is worse than useless to thrust our improvements by force or threats on the Chinese. When left themselves to the results of their own experience and slow methods of thought, their advances, though occasionally tardy, are surer and more satisfactory. It can hardly be a matter for wonder that a people who have been taught to revere the teaching of their sages for nearly 3000 years as the highest products of human wisdom, and whose minds have been cast in the same mould from a period long anterior to our era, should look askance at the inventions of the modern man of science who knows nothing of the system of ethics and politics of Confucius and Mencius, and the other sages of antiquity. A few years ago a foreign company in China constructed, without the formal sanction of the Chinese authorities, a line of railway a few miles in length between Shanghai and Woosung, at the mouth of the Shanghai River. The government repeatedly called for the cessation of the traffic on the ground that its consent had not been obtained, and that it did not want railways in its territories. Finally, in order to prevent any complications respecting ownership, it purchased the line, destroyed it utterly, and sent the materials to Taiwan in Formosa, where, according to the latest accounts, they were lying rotting; and they did all this notwithstanding the arguments and protests of foreign ministers and diplomatists. They were determined at all cost to rid themselves of an innovation which had been thrust on them. On the other hand, a recent *Peking Gazette* published a memorial from the Governor-General of Shansi, one of the most powerful officials in the Empire, requesting authority to lay down a line of railway to certain mines in his province. Preliminary surveys have already been made, and the memorialist goes so far as to demonstrate to the Emperor that had such a railway been in working order a few years ago, much of the misery and horrible loss of life in the Shantung famine might have been prevented. It is from bitter experiences such as these that the Chinese learn; the devices of diplomatists or promoters are thrown away on them.

THE VOYAGE OF THE "VEGA"[1]

THE voyage of the *Vega* will be in many respects one of the most memorable events in the history of navigation. For the first time a continent has been circumnavigated, so far as authentic record goes, and at last the North-East Passage has been won, after heroic efforts begun nearly three and a half centuries ago. As Baron Nordenskjöld reminds us in these volumes, the North-West Passage, although explored, has never been navigated entirely by any ship, McClure's famous journey having been accomplished partly in sledges over the ice. But the voyage will be still more memorable by the two rich volumes in which it finds copious record, volumes which have scarcely a parallel in the whole literature of geographical exploration. For Baron Nordenskjöld has not contented himself with merely telling the story of his own successful voyage and its results. That voyage, as we have said, crowns the efforts of centuries, and it has been by the results of these efforts that the *Vega* has accomplished her work with scarcely an adverse incident. It will be remembered that some six years ago Baron Nordenskjöld showed that the voyage from Norway to the mouth of the Yennissei could easily be accomplished in a week or two, if taken at the proper time. Since then trading ventures have gone over the course every year, and a regular trade-route may be held as established by the well-informed enterprise of the eminent Swedish professor. For something like twenty years Baron Nordenskjöld has been at work in the seas to the north of Europe, and mainly in Spitzbergen, and the rich results of them are known to all students of science, and their story was told about two years ago in an interesting work noticed in these pages. Thus he became probably more familiar with the ice-conditions of these northern seas than any other authority; and his success in the Yennissei expedition led him to think that there was no reason why the whole North-East Passage should not be navigated. But Baron Nordenskjöld is, above all, a man of science, and accustomed to go about his work in a scientific method. That he has the true spirit of adventure is proved by the work of half his lifetime, but then he has a weakness for entering upon his enterprises with his eyes open, of knowing where he is going, and what are likely to be the results to science. So before making up his mind about the North-East Passage, the Baron examined carefully all the records of previous voyages along the north coast of Europe and Asia, from the time of Othere, a thousand years ago, down to the latest adventures of the brave Norwegian skippers. Thus he found that at one time or other the whole of this stretch of coast had been navigated piecemeal, except the most northerly point of the old continent, Cape Chelyuskin,

[1] "The Voyage of the *Vega* round Asia and Europe; with a Historical Review of previous Journeys along the North Coast of the Old World." By A. E. Nordenskjöld. Translated by Alexander Leslie. Five steel portraits, numerous maps and illustrations. Two vols. (London: Macmillan and Co., 1881.)

which had baffled all the attempts of those daring Rus-

FIG. 1.—A, the Common Skua; B, Buffon's Skua; C, the Pomarine Skua.

sian sailors of the seventeenth and eighteenth centuries, who, in "floating coffins" and with many disasters, had explored the entire coast of Siberia. Baron Nordenskjöld saw that the ice in these regions has its times and seasons. To set out earlier than the middle of July he found would be to court delay and disaster. About that time the ice about Novaya Zemlya and in the Kara Sea begins to break up, and later on it generally retires from the north coast of Asia, being liable, however, to be blown south again by a north wind. In ordinary seasons, however, he inferred from the records of previous voyagers, a broad free lane of water might be looked for on to Behring Straits. In this respect the north coast of Asia differs materially from that of America. The eastern half of the latter is so hemmed in by islands that the ice has no scope for retiring completely, and so the North-West Passage under existing conditions is almost impossible for a ship. The fact that the ice is so easily blown black by a north wind to the coast of Asia gives ground to infer that a ring of islands stretches from Franz Josef Land to Wrangel Land, an inference confirmed by other characteristics. With his scheme so clearly and fully worked out, Baron Nordenskjöld went to the King of Sweden, who gave it hearty support. The result was that the king, in conjunction with the munificent Mr. Oscar Dickson of Gothenburg, who has spent a fortune in the cause of science, and Mr. Sibiriakoff, a Siberian merchant, agreed to advance the funds for an expedition round the continents of Europe and Asia. The *Vega*, a barque-rigged steamer of the best oak, 357 tons register, with engines of 60 horse-power, steaming 6 to 7 knots an hour, was bought, and specially fitted for her peculiar work. A staff of officers and men of science was carefully selected, and a picked crew of twenty-one men, with Baron Nordenskjöld himself as the leader of the expedition. The chief officer was Capt. Palander, of the Royal Italian Navy; Dr. F. R. Kjellman acted as botanist, Dr.

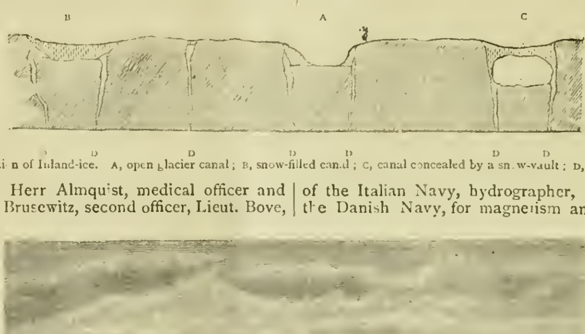

FIG. 2.—Section of Inland-ice. A, open glacier canal; B, snow-filled canal; C, canal concealed by a snow-vault; D, glacier-clefts.

Stuxberg, zoologist, Herr Almquist, medical officer and lichenologist, Lieut. Brusewitz, second officer, Lieut. Bove, of the Italian Navy, hydrographer, Lieut. Hovgaard, of the Danish Navy, for magnetism and meteorology, and

FIG. 3.—Glacier with stationary front, Udde Bay, on Novaya Zemlya, after a drawing by Hj. Théel (1875).

Lieut. Nordquist, of the Russian Guards, interpreter and zoologist. Baron Nordenskjöld, besides being eminent as a geologist and mineralogist, we need not say, was a host in himself. It will thus be seen that the expedition was perfectly equipped for scientific work.

We have said that Baron Nordenskjöld's work is far

more than a mere narrative of the voyage of which he was the organiser and commander. Not only does he give an exhaustive account of all previous voyages in these regions, but enters into the amplest details as to the scientific results achieved up to the present time. The work is thus a mine of unusual richness for the student of science, while it is so written as to be not only intelligible but delightful to any ordinary intelligent reader. As the *Vega* pursues her course, the leader stops every now and then to tell his readers of the voyages associated with a particular region, or of the knowledge we have of its geography, geology, and biology. Many matters of the widest scientific importance thus come to be introduced, and questions discussed of burning interest in various departments of science. In following the course of the *Vega* we shall attempt to give our readers some faint idea of the riches stored up in these two volumes.

The *Vega* was accompanied by the *Lena* as far as the mouth of the river of that name, for the commercial navigation of which she was destined, and part of the

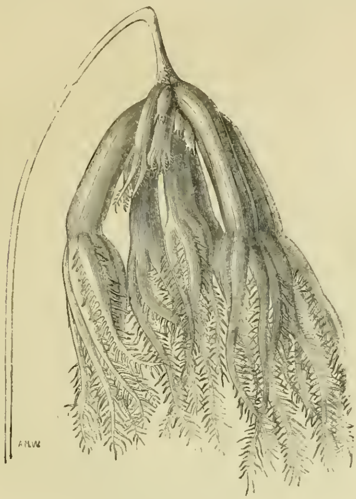

FIG. 4.—Umbellula from the Kara Sea.

way by the *Fraser* and *Express* as tenders. Coming round from Karlskrona, the expedition left Tromsoe on July 21, 1878. At Moosoe, near the North Cape, it was discovered that cloudberries and rum formed an excellent antidote to scurvy, and a stock was laid in, and whether from their use or from the carefully regulated diet on board the *Vega*, of which details are given, there was not a trace of scurvy during the whole voyage, and indeed no illness at all to speak of. As he rounded the corner of Europe, the Baron stops to tell us of early voyages in this direction, of Othere, whose story was told by King Alfred, Willoughby and Chancellor, Pet, and Jackman, and others, and to show us some old maps in which the coast is rudely laid down. The work is specially rich in maps from the tenth century down, including a large scale map of the north coast of Europe and Asia, in which the *Vega's* data have been incorporated. The vessels *rendezvoused* at Yuger Schar, between Waygats Island and the mainland on July 31. And here opportunity is taken of telling us all that is known about the Samoyeds of the island and mainland, from the earliest voyages down to the visit of the *Vega*, with abundant illustrations. Then follows a chapter of the greatest possible interest on the animal world of Novaya Zemlya, which becomes really an account of Arctic zoology. First we have a complete account of the birds, with wealth of illustration. The variety is wonderful, and evidently the habits of the interesting creatures have been carefully studied by Baron

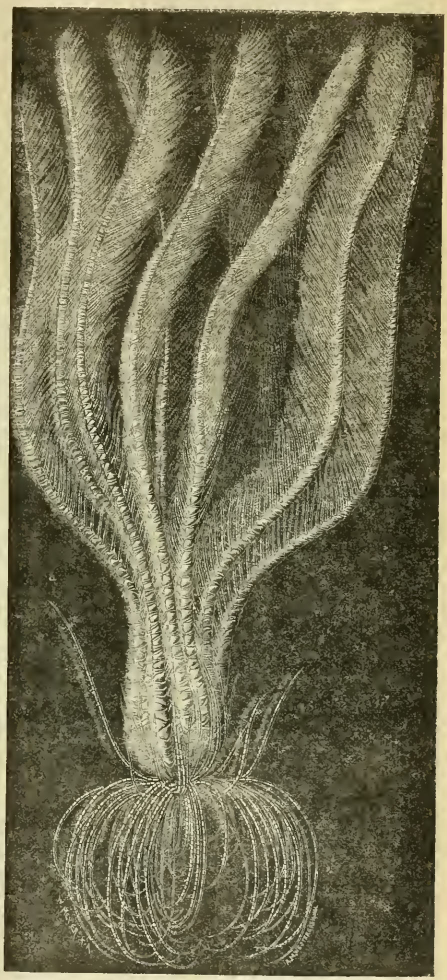

FIG. 5—Hairstar from the Taimur Coast (three-fifths of natural size).

Nordenskjöld. Here, for example, is a graphic picture, with its accompanying illustration (Fig. 1):—

"Often during summer in the Arctic regions one hears a penetrating shriek in the air. When one inquires into the reason of this it is found to proceed from a kittiwake, more rarely from a glaucous gull, eagerly pursued by a bird as large as a crow, dark-brown, with white breast

and long tail-feathers. It is *labben*, the common skua (*Lestris parasitica*, L.), known by the Norwegian walrus-hunters under the name of *tjufjo*, derived from the bird's cry, '*I-o i-o*,' and its shameless thief nature. When the 'tjufjo' sees a kittiwake or a glaucous gull fly off with a shrimp, a fish, or a piece of blubber, it instantly attacks it. It flies with great swiftness backwards and forwards around its victim, striking it with its bill, until the attacked bird either drops what it has caught, which is then immediately snapped up by the skua, or else settles down upon the surface of the water, where it is protected against attack. The skua besides eats eggs of other birds, especially of eiders and geese. If the eggs are left but for a few moments unprotected in the nest it is immediately to the front and shows itself so voracious that it is not afraid to attack nests from which the hatching birds have been frightened away by men engaged in gathering eggs only a few yards off. With incredible dexterity it pecks a hole in the eggs and sucks their contents. If speed is necessary this takes place so quickly and out of so many eggs in succession that it sometimes has to stand without moving, unable to fly further until it has thrown up what it has swallowed. The skua in this way commonly takes part in the plundering of every eider island. The walrus-hunters are very much embittered against the bird on account of this intrusion on their industry, and kill it whenever they can. The whalers called it 'struntjaeger'—refuse-hunter—because they believed that it hunted gulls in order to make them void their excrements, which 'struntjaegeren' was said to devour as a luxury. The skua breeds upon low, unsheltered, often water-drenched headlands and islands, where it lays one or two eggs on the bare ground, often without trace of a nest. The eggs are so like the ground that it is only with difficulty that they can be found. The male remains in the neighbourhood of the nest during the hatching season. If a man, or an animal which the bird considers dangerous, approaches the eggs, the pair endeavour to draw attention from them by removing from the nest, creeping on the ground and flapping their wings in the most pitiful way. The bird thus acts with great skill a veritable comedy, but takes good care that it is not caught."

Again he tells us of the snow-bunting:

"During excursions in the interior of the land along the coast, one often hears, near heaps of stones or shattered cliffs, a merry twitter. It comes from an old acquaintance from the home land, the *snoesparfven* or *snoelaerkan*, the snow-bunting (*Emberiza nivalis*, L.). The name is well chosen, for in winter this pretty bird lives as far south as the snow goes on the Scandinavian peninsula, and in summer betakes itself to the snow limit in Lapland, the *tundra* of North Siberia, or the coasts of Spitzbergen and Novaya Zemlya. It there builds its carefully-constructed nest of grass, feathers, and down, deep in a stone heap, preferably surrounded by a grassy plain. The air resounds with the twitter of the little gay warbler, which makes the deeper impression because it is the only true bird's song one hears in the highest north."[1]

Then Baron Nordenskjöld goes on to do for the mammalia the same service he has done for the birds, beginning with the reindeer. It thrives as far north as 80° and 81°, and in a temperature of − 40° to − 50° C.

"It is remarkable that the reindeer, notwithstanding the devastating pursuit to which it is exposed on Spitzbergen,[2] is found there in much larger numbers than on North Novaya Zemlya or the Taimur Peninsula, where it is almost protected from the attacks of the hunter. Even on the low-lying part of South Novaya Zemlya the reindeer, notwithstanding the abundance of the summer pasture, is so rare that when one lands there, any reindeer-hunting is scarcely to be counted on. It first occurs in any considerable numbers farther to the north, on both sides of Matotschkin Schar."

Notwithstanding the immense destruction of the reindeer in recent times their numbers in Spitzbergen keep so well up that it has been supposed they migrate from Novaya Zemlya. But Baron Nordenskjöld shows that this is not the case, as the reindeer of the two islands belong to different races. The fact that *marked* reindeer have been found in Spitzbergen has also led to the supposition that they found their way from some more northerly inhabited land, a supposition that does not seem probable, but is certainly worth verifying. Then we have our old friend the Polar bear, followed by the mountain-fox and the lemming. The marine life of these northern regions makes up amply for any scarcity of life on land.

"Here animal life is exceedingly abundant as far as man has succeeded in making his way to the farthest north. At nearly every sweep the dredge brings up from the sea-bottom masses of decapods, crustacea, mussels, asterids, echini,[1] &c., in varying forms, and the surface of the sea on a sunny day swarms with pteropods, beroids, surface-crustacea, &c."

Of the higher animal types of these seas the walrus, now that the right whale is nearly extinct, is the most important, and therefore comes in for a long notice. Even the walrus has suffered greatly from excessive hunting, and unless precautions are taken, will go the way of the right whale. The walrus haunts particular places of Novaya Zemlya and Spitzbergen, attracted by the abundance of their special food, which does not consist, as is often stated, of seaweed, but of various living mussels from the bottom of the sea, principally *Mya truncata* and *Saxicava rugosa*. Seals and whales are also referred to at some length.

Through Yugor Schar the vessels steamed their way into the Kara Sea on August 1. And here we are told a great deal about inland ice and icebergs, and the rich life-conditions of the Kara Sea, its surroundings and hydrography. The remarks on inland ice are specially valuable, the subject being illustrated by the writer's extensive experience in Greenland and Spitzbergen. We reproduce here (Fig. 2) a section which he gives of inland ice, and a picture of a Novaya Zemlya glacier (Fig. 3). The inland ice, Baron Nordenskjöld tells us, is of too inconsiderable extent to allow of any large icebergs being formed. There are none such accordingly in the Kara Sea, and it is seldom that even a large glacier ice-block is to be met drifting about. Indeed the Baron tells us that the popular notion as to the frequency of true icebergs in the far north is quite erroneous, the actual fact being that icebergs occur in far greater numbers in the seas which are purely accessible. The abundance of life in the Kara Sea is remarkable, though this has only been recently known, the old notion on this point being quite erroneous. As a specimen of the life to be found in this sea, we give here an Umbellula (Fig. 4).

Dickson's Harbour, at the mouth of the Yennissei, was reached on August 6, and so the first stage of the voyage was happily completed. Beyond this all was new, but it seemed to be felt that if Cape Chelyuskin was safely passed, all the rest would be comparatively easy. Here upwards of 100 pages are devoted to various topics of

[1] There are, however, various other song-birds found already on south Novaya Zemlya, for instance, *lappsparfven*, the Lapland bunting *Emberiza lapponica*, L.), and *berglaerkan*, the shore-lark (*Alauda alpestris*, L.). They hatch on the ground under bushes, tufts of grass, or stones, in very carefully constructed nests lined with cotton-grass and feathers, and are not uncommon.

[2] The hunters from Tromsoe brought home, in 1863, 996; in 1869, 975; and in 1870, 837 reindeer. When to this we add the great number of reindeer which are shot in spring and are not included in these calculations, and when we consider that the number of walrus-hunting vessels which are fitted out from Tromsoe is less than that of those which go out from Hammerfest, and that the shooting of reindeer on Spitzbergen is also carried on by hunters from other towns, and by tourists, we must suppose that at least 3000 reindeer have been killed during each of those years. Formerly reindeer stalking was yet more productive, but since 1870 the number killed has considerably diminished.

[1] Echini occur only very sparingly in the Kara Sea and the Siberian Polar Sea, but Novaya Zemlya at certain places in such numbers that they almost appear to cover the sea-bottom.

interest suggested by the arrival of the Expedition at the mouth of the Yennissei. Evidence is given to prove that the lower Yennissei must at one time have been thickly inhabited, but is now quite deserted, probably owing to the difficulty of procuring food, a difficulty that may be solved by the enterprises begun by Baron Nordenskjöld. A long list of phanerogams is given, collected during the stay of the expedition. Some interesting dredging results were obtained, and on this subject Baron Nordenskjöld writes :—

"For the science of our time, which so often places the origin of a northern form in the south, and *vice versâ*, as the foundation of very wide theoretical conclusions, a knowledge of the types which can live by turns in nearly fresh water of a temperature of + 10°. and in water cooled to − 2°·7, and of nearly the same salinity as that of the Mediterranean, must have a certain interest. The most remarkable were, according to Dr. Stuxberg, the following: a species of Mysis, *Diastylis Rathkei*, Kr., *Idothea entomon*, Lin., *Idothea Sabinei*, Kr., two species of Lysianassida, *Pontoporeia setosa*, Stbrg., *Halimedon brevicalcar*, Goës, an Annelid, a Molgula, *Yoldia intermedia*, M. Sars, *Yoldia* (?) *arctica*, Gray, and a Solecurtus."

On the long Yalmal Peninsula on the west of the Gulf of Obi, the author collects all the information known, but that is not much. The ground everywhere seems to consist of sand and sandy clay, and Baron Nordenskjöld, when he landed, could not find a stone so large as a bullet or a pea. Two chapters are devoted to a history of the navigation of the North-east Passage from 1556 to 1878; an admirable summary, containing much that is the result of the author's own research, and which never before has seen the light. Especially is this the case

Fig. 6.—The *Vega* and *Lena* saluting Cape Chelyuskin.

with the numerous Russian voyages of the seventeenth, eighteenth, and nineteenth centuries, of which little is known, but the results of which Baron Nordenskjöld acknowledges have been of the greatest service to him in forming his own plan. To the efforts of the Norwegian walrus hunters, too, Carlsen, Tobiesen, Johanessen, and others, he does full justice; and indeed their contributions to science have often been of substantial value; Johanessen, was awarded two medals by the Swedish Academy for his discoveries.

Port Dickson was left on August 10, and as the *Vega* steamed north-east to Chelyuskin over an imperfectly mapped coast, she came across many new islands, and other novelties which we cannot refer to in detail. Animal life along the Taimur coast was much scarcer than in previous parts of the voyage, though on the other hand the sea yielded some fine specimens. We give as an example a hairstar (Fig. 5) from off the coast.

The northern promontory of Asia was reached on August 19, and Baron Nordenskjöld describes the landscape as "the most monotonous and desolate I have ever seen in the High North" (Fig. 6). Here, however, we must leave the *Vega* till next week.

(*To be continued.*)

NOTES

Taking a retrospective *coup d'œil*, in a recent issue of his paper, of the Paris Exhibition, Count du Moncel notes, among other points, the marked success of the lectures, and the eagerness of the public to be instructed. A permanent electrical exhibition, with like facilities, would greatly promote the development of electric industries. The number of practical electricians in France is at present very limited, and while there are some very skilful makers of telegraphic apparatus and instruments for

electrical physics, yet (if electroplating be excepted) there are no great industries giving rise to electric works like those of the cable-manufacturing houses in England, or those of Siemens and Felten in Germany. The Count hopes "our *élan* henceforth will not be confined to mere publication of electric papers." Again, a desideratum at the Exhibition was the attachment of placards to apparatus, indicating its object and general arrangement. This is a matter worth attention in our forthcoming Exhibition. At first there was some talk about giving evening concerts at the Paris Exhibition, but the fact that the city had agreed with the concert at Besselièvre, behind the Palais de l'Industrie, not to allow any concert performances within a radius of 100 m., was a difficulty. It is doubtful (the Count says) if such concerts would have much increased the evening attendance, which was always large. With regard to the Crystal Palace Exhibition, he considers it should have been put off for a year.

ON the proposition of M. Cochéry, Minister of Posts and Telegraphs, the Minister of Foreign Affairs and President of the Council has nominated Dr. Warren De La Rue, F.R.S., correspondent of the Institute (Academy of Sciences), a Commander of the Legion of Honour, in recognition of his services at the Electrical Congress and as vice-president of the jury. We regret to learn that Dr. Warren De La Rue, in consequence of ill health, has been compelled to resign the important post of Honorary Secretary to the Royal Institution.

THE Lightning-Rod Conference formed by delegates from the Meteorological Society, the Royal Institute of British Architects, the Society of Telegraph Engineers, and the Physical Society, which has been at work since November, 1878, has at last completed its labours and prepared its report, which, together with an enormous mass of information that has been most assiduously got together, will very soon be published. The report will consist of a brief description of the purposes which a lightning-conductor is intended to serve; a statement of those features in the construction and erection of lightning conductors respecting which there is a great difference of opinion; and the final decision on the points in question arrived at by the Conference. It will also contain a simple code of rules for the erection of lightning-conductors which any ordinary non-technical individual will be able to understand. It is hoped that the success of the publication will justify the labour that has been expended upon it. It will be published in the form of a book by Messrs. Spon and Co.

IN view of the recent great development of the telephonic system, the Directors of the Magdeburg Fire Insurance Company have lately sought information from the Secretary of the Imperial Post Office, Dr. Stephan, as to whether the danger from lightning was increased by the overhead wires and iron supporting rods, and whether special conditions of insurance should be made for houses in proximity to such wires. Dr. Stephan has replied that no case had yet come to his notice in which lightning had done injury in the way referred to. The experience of the German Post Office with telephone lines was indeed short; but in other countries there was an experience of overhead telegraph lines, which was of several years' extent, and he was not aware that observations had occurred in this connection which had given any occasion for anxiety about lightning. It was important, in arranging those telephone lines, to take care that any atmospheric discharges which might affect them should have a sufficient path to earth. Such being the case the telephone wires might even afford houses a protection against lightning which they would otherwise lack. The directors of the insurance company think it at present unnecessary, therefore, to make any change in their terms in the case of houses over which telephone lines pass.

WE regret to have to record the death of Mr. Charles Moore, the well-known geologist of Bath. Mr. Moore was known as a most indefatigable and successful collector. On one occasion he carted from a fissure near Bristol two tons of the celebrated bone-bed. This when sifted and examined afforded no less than 45,000 teeth, besides portions of many fish and reptiles. Most important of all, it yielded nineteen teeth of the Triassic mammifer *Microlestes*, which Mr. Moore had thus the good fortune to discover. On another occasion he astonished the British Association by his power of predicting from the forms of nodules the genera of fish which would be found inclosed in them when they were broken open. His interesting discovery of Liassic shells in lead veins traversing the carboniferous limestone was the subject of a most valuable communication to the Geological Society, and he was also one of the first to recognise the importance of the Rhætic formation in this country. The Museum at Bath owes much to the persevering labours of Mr. Charles Moore.

A REUTER's telegram, dated New York, December 18, announces the death of Dr. Isaac J. Hayes, the Arctic explorer. Dr. Hayes, it will be remembered, was surgeon of Dr. Kane's second Arctic expedition, with which he returned to the United States in 1855. A conviction that there existed an open Polar sea induced him in 1860 to undertake a voyage of exploration on his own account. He sailed from Boston in the schooner *United States*, and by means of sledges he penetrated as far north as 81 deg. 37 min. He again visited Greenland in 1869. To the last he was desirous of heading another expedition to the North Pole by way of Smith's Sound. His voyage in the *United States* was described in "The Open Polar Sea;" and among other works from his pen were, "An Arctic Boat Journey," relating to his first voyages; "Cast away in the Cold," a supplementary narrative of his second voyage, published in 1870; and an account of Greenland under the title of "The Land of Desolation." The Geographical Society of London and the Société de Géographie of Paris awarded him gold medals for his discoveries.

THE death is announced, at the age of seventy two, of the Rev. Dr. John Ludwig Krapf. Dr. Krapf was a missionary of the Church Missionary Society in East Africa from 1837 to 1853, and did much for the exploration of the region north-west of Zanzibar, in company with Dr. Rebmann. They are known specially as the discoverers of Kilimanjaro and Mount Kenia.

IN a paper published in the July number of the *Archives des Sciences Physiques et Naturelles* of Geneva, which we referred to at the time, M. F. Forel established, by observations of the oscillations of the lowest extremity of the glacier of the Rhone since 1856, that, although two causes determine the position of the end of a glacier, nevertheless the chief of them is not the fusion of this end by the summer heat, but the rate of advance of the glacier. As the latter depended upon the thickness of the glacier, he concluded that the variations of the length of a glacier depend chiefly upon the variations of its thickness. Measurements having shown considerable variations of thickness at the lower end of the Rhone glacier, these might be easily explained by very small changes in the thickness of the *nevé*, which changes are, so to say, exaggerated by the mutual relation of the rate of advance and the thickness, producing thus immense changes in the length of the glacier. Glacialists will appreciate the great importance of these observations of M. Forel, as they may explain an immense increase of glaciers without great variations of temperature, but only by small changes in the distribution of snow and rain which fall upon a country. However, as is pointed out by those glacialists who have sought for the key of the glacial period in an accurate

study of what is going on now in Arctic countries, this relation has been rather neglected. In a second paper, which has just appeared in the November number of the *Archives*, M. Forel discusses the influence of ablation on the thickness of a glacier, the ablation, together with the amount of snow fallen on the surface of the *nevé*, being the two chief causes of changes in thickness. Our knowledge of the influence of ablation is almost nothing; but the influence due to an increase, or decrease, of the feeding of a glacier being felt, and exaggerated, throughout the whole length of a glacier, while the ablation has an importance only in its lower parts, M. Forel concludes that this second cause never would have the importance of the first. In any case both causes never can be simultaneous, the *nevé* taking fifty or a hundred years to reach the low end of the glacier; thus the thickness of a glacier at this end depends upon the quantity of snow fallen on the *nevé* some fifty or a hundred years ago, and on the ablation during a few recent years, which causes may be either concurrent, or opposing, in increasing or decreasing the thickness. He remarks also that altogether it seems that the retreat of glaciers, which reached its maximum about the year 1875, was not a local phenomenon, but was simultaneously observed in the Austrian Alps, in the Pyrenees, in the Caucasus, in Scandinavia, and in Greenland. M. Forel concludes by asking the naturalists of all countries to indicate the advance and retreat of glaciers as much as possible in figures, and to measure the thickness of glaciers at several well-determined parts.

WE fear all hope must be given up as to the safety of Mr. Powell in the *Saladin* balloon. A balloon was seen on the night of the 16th, going by Santander and Bilbao towards the sea, but nothing more has been heard of it. It may have been the *Saladin*, but if so, and Mr. Powell had been in it and conscious, he would certainly have made some sign. Mr. Powell was an ardent and intelligent aëronaut, and his death, which we fear is only too certain, must be regarded as a loss to science in the pursuit of scientific knowledge.

THE Royal Italian Scientific Institution at Venice offers a number of prizes for various memoirs. Among them we note the following two as of more general interest:—(1) "A Statement of the Hypotheses recently advanced by Physicists on the Causes of the Phenomena of Light, Heat, Electricity, and Magnetism" (prize 3000 lire (about 110*l.*), term March 31, 1883). (2) "A Systematical and Critical Enumeration of the Cryptogamic Plants hitherto observed in the Venetian Provinces" (prize and term for this treatise are not yet fixed).

THE death is announced, on November 29 last, of Dr. Wilhelm Weith, Professor of Chemistry at Zürich University. He died in the Island of Corsica, where he was staying on a visit, at the early age of thirty-seven years.

IN the night of November 19–20 the tunnel through the Col di Tenda, on the frontier between France and Piemont, was broken through. Cuneo is the nearest place on the Italian side of the mountain, where the Italian railways will join the new French branch extending through the tunnel.

WE have on our table the following books:—Cultivation of Liberian Coffee, by H. A. A. Nicholls (Silver and Co.); Report of the Scientific Results of H.M.S. *Challenger*, 1873–76, Vol. iii. Zoology; Koumiss, by G. L. Carrick (Blackwood); Every-day Life in Our Public Schools, edited by C. E. Pascoe (Griffith and Farran); Statistical Atlas, Parts x. and xi., by C. P. Bevan (W. and A. K. Johnston); Perfect Way in Diet, by Anna Kingford (Kegan Paul); Educational Theories, by Oscar Browning (Kegan Paul); The Bedfordian System of Astronomy, by J. Bedford (H. Vickers); Description of the Chemical Laboratory at the Owens College, Manchester, by Prof. H. E. Roscoe, F.R.S. (Cornish); Ideality in the Physical Sciences, by B. Peirce (Little, Brown and Co.); European Ferns, by James Britten (Cassell, Petter, and Galpin); The Encyclopædic Dictionary, by Robert Hunter (Cassell, Petter and Galpin); John Amos Comenius, by S. S. Laurie (Kegan Paul); Elementary Treatise on Electricity, by Prof. Clerk Maxwell (Clarendon Press); Astral Origin of the Emblems and Hebrew Alphabet, Rev. J. H. Broome (Stanford); Encyclopædia Brittannica, vol. xiii. (A. and C. Black); Old Greek Education, by J. P. Mahaffy (Kegan Paul); Practical Chemistry, by Howard (William Collins); British Almanack and Companion (Stationers Company).

THE following recently-published Norwegian and Danish books may interest some of our readers:—"A Geological Description of the Lofoten and Vesteraalen Districts of Norway," by K. Pettersen, with maps, and with interesting remarks on the coal-bearing Jura formation of those provinces; "A Flora of Iceland," by M. Chr. Grönlund, being the results of his visits to Iceland during the years 1868 and 1876, from which he has brought back very rich collections of plants; the flora of Iceland includes, according to M. Grönlund, 870 species, of which 332 are Phanerogams, the total number having to be increased by many Algæ; "From Fields and Forests: Pictures of the Life of Insects," in two volumes, by M. v. Bergsöe; and a pamphlet, by M. R. Lehmann, on the former coast-lines in Norway.

S. A. LEXE, who steadily pursues his studies on the recent geology of Norway, contributes to the last number of the Norwegian *Archiv* for mathematics and natural science, a paper on the upheaval of Norway, and its coast-lines and terraces.

ADVICES received at Plymouth give some particulars of a destructive typhoon which visited Haiphong and Tallee on October 8, causing great destruction and loss of life. The wind blew with tremendous violence, and the heavy sea flooded the whole of the surrounding country. In Tallee there were six feet of water in the houses three and four miles distant from the sea-shore. The current was so strong that it swept away the entire town, the number of persons drowned being estimated at over 3000.

IN the December number of the serial *Auf der Höhe*, Prof. Palmieri, the Director of the Observatory on Mount Vesuvius, communicates a discovery with regard to volcanoes. In a series of spectro-analytical examinations of the lava Prof. Palmieri has, it is stated, just discovered a new line which corresponds exactly with that of helium, the famous element hitherto seen in the solar spectrum only.

THE displacement of *isotherms* (or lines drawn through places having an equal mean temperature), with the season, has some interesting practical bearings. Several years' recent (so-called) phenological observation in Sweden proves that in general each phenomenon of plant-life occurs only at a certain temperature. A similar rule applies to the arrival of many birds of passage. Comparing the times such phenomena take to advance one degree of latitude, it is found on the Baltic coast that their greatest velocity is in midsummer. The numbers of days for an advance of one degree are in sundry cases as follows:—Freeing of lakes from ice 6·0, flowering of April plants in Southern Sweden 4·3, of May plants 2·3, of June plants 1·5, of July plants 0·5, appearance of leaves (general average) 2·3, ripening of fruit 1·5, fall of leaves 2·3, freezing of lakes 5·1. A recent study by Herr Hildebrand (of Upsala) of the movement of isotherms in the north of Europe throws light on these facts, showing (among other things) that while in Sweden the rate of the movement increases with the temperature, in Russia it remains nearly constant. The author gives a number of maps for various temperatures. Taking 0° it is found that the isotherms running nearly north and south move eastwards, but in

the interior of the continent they are bent at a right angle, extending east and west, and moving to the north. In the map for 9° the influence of greater heating of land than of sea is apparent. The isotherms are nearly straight lines east and west, and move from south to north. For 12° they extend west-south-west to east-north-east, and move towards north-north-east.

IN the wave of administrative economy which has passed over Japan during the past three years, education has, we regret to notice, suffered. The allowance to the Education Department for the current year is only 914,601 *yen* against 1,181,100 *yen* last year—a reduction of 266,499 *yen*, or nearly 25 per cent. The expenditure on working the mines has also been diminished nearly 50 per cent. It is right to observe, however, that the estimates of every department have been largely cut down, and that much of the decrease under the head of education may be attributed to the substitution of native teachers for highly-paid foreign professors.

MR. H. TRUEMAN WOOD, Secretary of the Society of Arts, asks us to draw the attention of our readers to the Exhibition of Photographic Apparatus which the Society proposes to open next month. They hope to be able to include in the Exhibition apparatus illustrating some at least of the many applications of photography to scientific purposes, and Mr. Wood will be very grateful to any person who will entrust the Society with any such apparatus to be shown during the short time the Exhibition will remain open. Mr. Wood will gladly send full particulars of the Exhibition to anybody sufficiently interested in the matter to apply for them.

PROF. R. S. BALL, Royal Astronomer of Ireland, will give the first of a Course of Six Lectures on the Sun, the Moon, and the Planets (adapted to a juvenile auditory), at the Royal Institution on Tuesday next, the 27th instant.

A VIOLENT shock of earthquake is reported from Agram on November 20, at 8.27 a.m. The duration of the shock was two seconds, its direction perpendicular, and its intensity so great that a panic was caused, and the schools remained closed for the day. Earthquakes are reported (1) from Stassfurt, where a violent shock occurred on December 2 at 4.18 a.m., causing considerable damage in the salt-mine of Leopoldshall; (2) from Siders (Valais), where a strong shock was noticed on December 4 at 2.55 a.m.; (3) from Agram, where a shock of two seconds duration occurred on December 9 at 9.55 a.m.

THE annual meeting of the Geographical Society of Paris has been held for the first time under the presidency of M. de Lesseps. The meeting was numerous and enthusiastic. M. de Lesseps gave an address in which he eulogised his predecessor, Admiral La Roncière le Noury, who died recently. On the following evening the usual banquet took place at the Hotel Continental.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*) from South Africa, presented by Capt. Wyld; two Squirrel Monkeys (*Chrysothrix sciurea*) from Demerara, presented by Mr. F. N. Apthorp; a Black-backed Jackal (*Canis mesomelas*) from South Africa, presented by Capt. C. Hollard Smith; two Ferrets (*Mustela furo*) from Japan, presented by Mrs. J. F. Faed; a Bosch-bok (*Tragelaphus sylvaticus*) from South Africa, presented by Mr. E. W. Berryman; a Rose-coloured Pastor (*Pastor roseus*) from India, presented by Mr. F. Lubbock; a Herring Gull (*Larus argentatus*), a Greater Blacked-backed Gull (*Larus marinus*), European, presented by Mr. E. W. Ebsworth; six Dwarf Chameleons (*Chamæleon pumulus*) from South Africa, presented by Col. Hassard, R.E.; a Green Monkey (*Cercopithecus callitrichus*), a Mona Monkey (*Cercopithecus mona*) from West Africa, a Cerastes Viper (*Vipera cerastes*) from Algeria, deposited; four Snow Buntings *Plectrophanes nivalis*), two Common Siskins (*Chrysomitris spinus*), British, purchased.

OUR ASTRONOMICAL COLUMN

A VARIABLE OF THE ALGOL TYPE.—A telegram to the Earl of Crawford's Observatory at Dunecht, notifies that Mr. Sawyer of Boston, U.S., has detected a variable of the comparatively rare type of Algol, with a period of 5·24 days, its brightness varying between 6·0 and 6·7, and 1881, November 30·84 being an epoch of minimum. It is number 854 of Sir J. Herschel's third series of observations with the 20-feet reflector, published in Vol. iii. of the *Memoirs* of the Royal Astronomical Society; it is there called 5m. with a minute companion 88° n.p. 25", and a note says, "not in Piazzi": these observations were made in 1827-28. The star is Lalande 31384, observed 1797, May 24, and estimated 6½; Bessel calls it 7m. in July 1822, and Santini has the same magnitude at the end of July or beginning of August 1838. Lamont has two observations at which it was estimated 7m. and 8m. In the *Durchmusterung* it is 5·5, and on the Atlases of Argelander and Heis 6m. Schjellerup called it 7·7 on 1863, June 9, and in his catalogue of 1864 he pointed out the differences in the estimated magnitudes of previous observers. Dr. Gould, in the *Uranometria Argentina* mentions that a series of comparisons between August and October 1871, indicated "an oscillation of magnitude from 6·0 to 6·5, but exhibiting no regular law in the variation"; in the catalogue he has "6·7 var.?" Taking into consideration the estimates of various observers it might be inferred the true limits of magnitude may be somewhat wider than assigned above. The position of the star for 1882·0 is in R.A. 17h. 10m. 33s. Decl. + 1° 20'·6.

A PROBABLE VARIABLE-STAR.—The following is a case which appears to be worthy of attention:—D'Agelet observed a star in 1783, on July 26, 27, and 29, which he estimated on the three nights 6, 6, and 6·5 respectively. It is No. 5057-59 in Dr. Gould's reduced Catalogue, and there called *Anonyma*: in fact it is not found, so far as we know, in any modern catalogue except the *Durchmusterung*, where it is +17°, 3997, and estimated only 9·4. The place of the star from D'Agelet, brought up to 1880·0, is in R.A. 19h. 27m. 22·10s., Decl. +17° 29' 28"·0·

THE BINARY STAR η CASSIOPEIÆ.—The elements of this beautiful revolving double-star, which had been already calculated by Duner, Doberck, and Gruber, in 1875 and 1876, have been newly investigated by Ludwig Struve, son of the present director of the Imperial Observatory at Pulkowa. The principal characteristic of the new orbit consists in its depending entirely upon the measures of Bessel and the two Struves between 1830 and 1878, the early data of Sir W. Herschel, which, if taken into account, would exercise an influence much greater than is due to their degree of accuracy, being left out of consideration. The resulting elements are as follow:—

Periastron passage ...	1905·02	Inclination ...	56° 22'
Node	45° 3'	Eccentricity ...	0·6296
Node to periastron ...	238°·17	Semi-axis major	8"·786
For Eq.	1850·0	Period of revolution	148·90 yrs.

Duner had found the period 176, Gruber 195, and Doberck 222 years. A comparison with the measures of Dembowski (1856-76) and Duner (1868-75) exhibit constant differences, upon which M. O. Struve remarks at some length in a note to his son's memoir (*Bulletin de l'Acad. des Sciences de St. Petersbourg*, tome v.).

According to the above orbit the components close in until the year 1907, when their apparent distance is at a minimum of 1"·9 on an angle of about 305°. To test the longer and shorter periods we have:

	In Doberck's Orbit.		In L. Struves's Orbit.	
1882·0 ...	162°·1 ...	5"·54	165°·8 ...	5"·44
1883·0 ...	164·6 ...	5·51	168·1 ...	5·40

M. Otto Struve's observations gave for the parallax of this star 0"·1543 ± 0"·0450, whence the mass of the two components results 8·33 times that of the sun, and the author of the memoir further concludes that the larger star has a mass 6·57 times, and the smaller one 1·76 times the solar mass. Prof. Auwers finds the proper motion of η Cassiopeiæ + 0·1346s. in right ascension, and − 0"·481 in declination, or 1"·196 in great circle, in the direction 113°·7.

SOLAR PHYSICS [1]

II.

WE now have to consider what is the best method by which we can obtain, not a reversed image of the infra-red region, but a direct image of that portion of the spectrum ; the problem had to be attacked in an experimental manner. It was really a matter of physics, and nothing more ; the chemical question was *hors de combat.* Every silver salt which I have already shown you, you saw absorbed in the blue end of the spectrum, and not in the red ; and therefore from what I had previously told you, you were prepared to hear that those salts would not be photographically effective for the red end of the spectrum, although they would be eminently so for the blue end. The question then we asked ourselves was this : Is it possible to obtain a silver salt which shall absorb in the red end of the spectrum? Is it possible, for instance, to obtain a salt of silver which will exhibit two molecular states—one absorbing in the blue, and the other in the red? If we turn to other bodies I think I can show you that there are bodies which exist in two or more molecular states. The very example of obtaining a reversed negative in the red of the spectrum by Draper's plan is an example of it. I have here another very good example of the oxidation process. This is chloride of silver paper which has been darkened by white light, and you will see that it has a tint which naturally would absorb to a certain extent the red rays. You will further see by the oxidising action we are able to produce a coloured oxide of silver. In other words, we have a coloured spectrum produced by the action of light itself, owing to the oxidising process. Alongside of this is the spectrum, taken on similar paper, without any preliminary exposure to light. You see where we get a darkened salt we have an impression of the spectrum in various colours, beginning with the blue, green, and then the red of the spectrum. Where the red end of the spectrum is you have a red oxide of silver formed.

Now let me show you that there are two different molecular states of elementary matter with which we are well acquainted. First of all I will throw a spectrum on the screen, and try to show you that there are two forms of iodine which absorb in different parts of the spectrum, telling us that they are molecularly different, when in solution at all events. The spectrum is on the screen, and I place a solution of iodine which has been dissolved in water in front of the slit, and you see that it cuts off the whole of the blue end of the spectrum, leaving only a red band. If you look at the white screen on the wall on the right you willsee an image of the slit reflected from the back of the prism, which gives the real colour of the iodine in solution. In this form, then, we have one molecular state of iodine. We will take another molecular state obtained by dissolving it in bisulphide of carbon. You see that we have a totally different absorption. The yellow is cut out, and the blue and also the red are left behind. Here, then, is one proof that we can have two molecular states of an element. But there is another interesting example in gold. If you will allow me to read from a book written by my colleague, Mr. Lockyer, he refers to the two molecular states of gold ; and if possible, I should like to show you those different molecular states as far as we can on the screen. After talking about different kinds of spectra he goes on to say : "Gold is sometimes yellow, as you know, but gold is sometimes blue and sometimes red. It must be perfectly clear to all that if particles vibrate, the colours of substances must have something to do with the vibrations. If the colours have anything to do with the particles it must be with their vibrations. Now as the spectrum in the main consists of red, yellow, and blue, the red and the blue rays are owing to something in a substance which only transmits or reflects the yellow light : if we put gold leaf in front of the limelight, we can see whether the yellow light does or does not suffer any change. The yellow disappears ; we have a green colour ; the red and blue are absent. The gold leaf is of excessive thickness. What would happen could I make it thicker? Its colour would become more violet. This I have proved by using aqua regia. But we can obtain a solution of fine gold which lets the red light through. Its particles are doing something with the blue vibrations. We can obtain another solution which only transmits the blue. Now what is the difference—the 'particular' difference—between the gold in these solutions and that which is yellow by reflected light, and green or violet by transmitted light? It is a question worthy of much study." [1]

I will now throw on the screen an image of a thin film of gold kindly lent me by Mr. Lockyer, and you will see the colour of gold as it really is. It is not yellow, as we ordinarily know it, but is green when of that particular thickness, and it cuts off the red of the spectrum. I have here a solution of gold, which however does let red light through. It is purely metallic gold precipitated in water, and you will see what a beautiful red colour this has. This ruby colour of gold was first obtained by Dr. Hugo Müller, and experimented upon by Faraday. You can obtain also another solution of gold which is a greenish blue. It is rather a ticklish thing to show on the screen, but I daresay we shall be able to show it to you. Thus, then, we have gold in three states : the red molecular state, the blue molecular state, and the green molecular state ; or perhaps the green may be referred to the difference between those two, or a combination of those two. Evidently, then, it is possible to obtain matter in two or three molecular states at the very least.

Now to apply this to our silver salts. Experience seems to show that the green molecules will be much more likely to absorb in the red than the blue molecules. I will just try to explain this by passing one or two green bodies before the slit of the spectrum apparatus (Fig. 6). In this green glass, for instance,

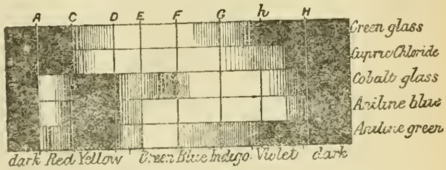

FIG. 6.—Absorption spectra of different coloured matters.

you see that the red is cut off markedly from the green. Now if we take a solution of a salt of copper—chloride of copper—you will remark that the same phenomenon presents itself ; we have the red cut off as well as the blue. You may ask the question whether a blue colour may not be equally as effective in absorbing the red as the green. I think I can answer this question experimentally. Here we have a piece of ordinary blue glass ; you will see that although the red of the spectrum is dimmed to a certain extent, still a streak of red appears, and the principal absorption takes place in the yellow. One would naturally infer that as the red was not entirely cut off, those rays which lie below the red would also not be cut off. That, practically speaking, is found to be the case. We will take an ordinary blue dye, and you will find that we get the same phenomenon occurring. You will notice that the image of the slit on the side screen is a most beautiful Oxford blue, and you notice in the spectrum that it is gradually cutting out the yellow. Such experiments might be multiplied, but from what you have seen it is evident that a green is more likely to be effective as a red absorber than is blue, and this would apply also to the silver salt as regards the molecular state which we wish to produce.

You may ask me—why cannot we use a green dye according to Vogel's method, which I mentioned last time? I can show you on the screen what would have happened with a green dye. There are greens and greens : some greens absorb in the red, others do not. In the ordinary green dye, which is a very complex body, part of the blue and part of the yellow is cut off, but not the red or the green, and consequently, as the red appeared it was perfectly useless to attempt to dye a film in order to produce a photograph of that end of the spectrum. What remained then to do? It simply remained to take some *simple* silver salt itself, and then to convert it into the molecular state, which would absorb the red. After four years of labour we succeeded in effecting this. In this test-tube we have some precipitated bromide of silver, which, as you saw on the screen last time, is of a yellow tint, or rather of an orange tint. Now bromide of silver is to a very small extent soluble in nitrate of silver, more particularly when acidified with nitric acid ; and if such bromide of silver as we have here be boiled in a solution of

[1] Lecture delivered on May 25, 1881, at the Lecture Theatre, South Kensington Museum, by Capt. Abney, R.E., F.R.S. Continued from p. 166.

[1] P. 129, "Studies in Spectrum Analysis." by J. Norman Lockyer, F.R.S. ; "International Scientific Series." (Kegan Paul and Co.)

nitrate of silver together with nitric acid, particular particles of bromide of silver are dissolved by the nitrate of silver, and then are re-deposited, built up, as it were, into bigger and bigger molecules, until finally we find we have a bromide of silver which literally is green when placed before the lantern. These two plates are respectively coated with the two kinds of bromide; first we have the ordinary bromide; and second, the bromide modified in molecular structure in the way I have described. The light from the lantern traverses the two films placed side by side, and you will see that they are eminently different in every way: the one being of an orange tint, absorbs the blue rays, the other being of a greenish-blue tint, absorbs the red. Now to show you that those two states are identical as far as the chemical composition of the molecules is concerned, I will take the green bromide of silver film which I had just now, and rub it with my finger; you will find that the blue bromide is once more reconverted into the red bromide. It has been scratched a little

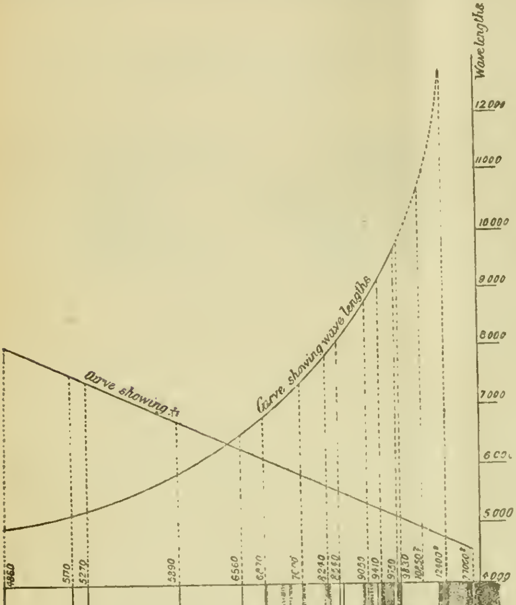

Fig. 7.—Diagram of the least refrangible portion of the solar spectrum.

in the rubbing, and you will see, where the scratching has taken place, that it is of a fine orange tint. Here then we have a solution of the problem, the production of a bromide which will absorb in the red as well as one which can absorb in the blue, which is the ordinary state.

Now no sooner was this bromide obtained than, of course, there was great interest displayed to test its effect as regards its being a photographic salt. To do this we naturally appealed to the spectrum. But here I have something which will be perhaps more efficacious in showing you what that salt can do than anything else. This is a photograph of the poles of an electric light taken through this sheet of black ebonite. It is perfectly opaque to all visible radiation, but through it those rays which are below the red can penetrate to a certain extent. You see then we are able to photograph with the dark rays, absolutely without using the visible rays at all. Another example of this might probably be interesting for you to see, and that is this: it is an experiment I carried out to-day, so that it is fresh in my memory. Here I have a card pierced with a few holes. That card was taken and laid very nearly, but not quite, in contact with this blue bromide film, and over it was placed a blackened kettle of boiling water. If those dark rays had any effect on the blue bromide, the radiations from the kettle of boiling water ought to alter the salt. Let us see whether it did so. The photograph is rough, but still I daresay it is specific enough to show you the result. You will see that the images of these holes are exactly reproduced, and the source of illumination, if it may be so called, was the kettle of boiling water, the radiations of which sufficed to cause an alteration in the silver salt. I have been able once—I have not tried to repeat the experiment—to photograph a kettle of boiling water by its own radiation; that is to say, it became a source of light.

We will next appeal to the spectrum to see whether it is sensitive to all the radiations, and I think you will find that it will answer our expectations to the highest degree. I have on the screen the first photograph of the prismatic spectrum which was taken with this salt. You will be able to note the position of the spectrum with regard to the blue, the green, the yellow, the red. Below the impression made by the latter we have the famous A line, and below this again we have an impression made by the infra-red rays. What we next attempted was of course to get better photographs than the one I have already shown you; and next to draw a map of the prismatic spectrum.

In the following diagram we have the results of the measurements of these photographs. You see to what an enormous extent the solar spectrum extends below the limit of the visible spectrum—the A line is seen with great difficulty in the spectroscope (Fig. 7). The last band in the photograph that I last showed you was the band marked τ, but below that there are other bands which I was subsequently able to obtain. It is very rarely that these bands can be photographed at all, not because the plate is not sensitive to those radiations, but simply because of the atmospheric absorption which cuts off these particular radiations and prevents them from reaching our earth. I may say that the theoretical limit of the prismatic spectrum is very nearly reached here—not quite, but nearly. Cauchet showed that if you set up along the length of the spectrum, as we have it here, the inverse square of the wave-length of any two lines, say the inverse square of the wave-length of the B line, and erected a perpendicular line of a length representing that particular number, and also of the wave-length of the F line say in the same way, and then joined of the points thus obtained, we should get a line on which the inverse squares of the wave-lengths of H G C D would lie, and also theoretically the wave-lengths of lines below the red. Thus if we took and joined two points, all the other inverse squares of the wave-lengths would lie along that line, very nearly. In that way a theoretical limit of the prismatic spectrum can be obtained; in other words, the prismatic spectrum must stop where the wave-length is infinity. You will see that in this diagram we very nearly reach the theoretical limit. Where there is no atmosphere to interfere with the radiation, it would be easy to reach it. Since the spectrum we photographed is the solar spectrum, between the slit and the source of radiation many miles of atmosphere with more or less aqueous vapour intervene, which prevent us obtaining the limit; but with the electric light the absolute limit can be reached on some occasions, though with some difficulty. It may be asked if we can assume that there is a practical as well as theoretical limit of the prismatic spectrum: and in answer to this I may say that the measurements made from other photographs, to which reference will be made, will demonstrate that one is fully justified in adopting the theory.

The disadvantage of using the prismatic spectrum for measurement is this: you will notice the waves are very much compressed as you get down towards the red. The ordinates to the curve (Fig. 7) represent the wave-length; and if you calculate the wave-lengths from the inverse squares given by the nearly straight line it forms a curve like the above.

Now owing to the compression of the ultra-red it was very difficult to decipher the full meaning of the impressions obtained

in this ultra-red region, more particularly as regards the resolution of bands into lines. You saw there were very few lines apparently, but there were bands, and the question asked was, Could we resolve these bands into lines? You recollect that Draper had in his photograph three lines below the limit of the red end of the spectrum taken by the oxidising process. They did not go very far down as it turned out, but still, there they were, and I think I can show you that those lines and bands are resolvable into lines. To do that, of course, we have to use a diffraction grating. On that stand I have a diffraction grating similar to the one Mr. Lockyer showed you, which was used in all the researches on the spectrum. We have on the screen the spectra produced by the grating; you will see that even the first two which lie next to the bright central image of the slit are much feebler than the spectrum you ordinarily see on the screen, as Mr. Lockyer pointed out. If you turn the grating further round you will see that another spectrum comes on, and by turning it still further we get a third, and so on. They are all feeble, but the two last very feeble indeed, but still they are present; of course by turning the grating in the other direction we should get similar spectra on the other side of the central image of the slit. By holding the screen up rather closer to the source of light, we shall be able to see the spectra better. I want you to notice that the violet of the third spectrum overlaps the red of the second spectrum. In order to photograph the ultra-red of the first spectrum it was necessary to use some artifice to cut out those invisible rays which lie between the violet and the red, and belong to the ultra-violet of the second spectrum, and also the violet and the blue, and the green of the same spectrum. In order to do that we used various absorbing media, but the most practicable for the purpose we had in view was a solution of bichromate of potash in water of about 1-25th of an inch in thickness. You will see that bichromate of potash cuts off the violet and the blue, and leaves the red and yellow intact. This solution was used with the diffraction spectrum to photograph the ultra-red regions. I will throw a diagram on the screen to show the overlapping of the different spectra, to make it more clear. You see in the second order the H lines comes a little beyond A (Fig. 8), and in the third line they come as far as the

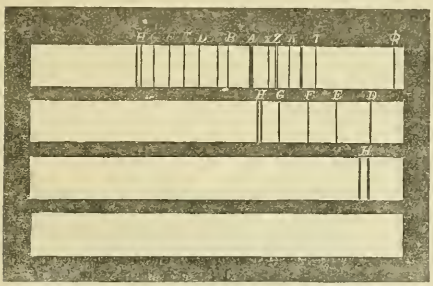

FIG. 8.—Overlap of the diffraction spectra of the 1st, 2nd, 3rd, and 4th orders.

D line. You will also notice that the bichromate of potash cuts off certain rays in the first order-spectrum, the same rays of the second-order spectrum, and those also in the third-order spectrum.

I will now throw on the screen some photographs taken with this diffraction spectrum [shown and explained].

That is as far as we have been able to distinguish with the diffraction grating up to the present time, although we have hopes that with more labour we shall be able to get further down, not to the theoretical limit of the spectrum as shown by the diffraction grating, since that is infinitely far down, but at all events towards that way. In order to show how we can plot the wave-lengths it is only necessary to use the same plate of green bromide and to expose half the slit to the second-order spectrum for the blue end, and the other half to the first order of the red end of the spectrum, using, of course, proper absorbing media. In this photograph we adopted this artifice. The top half of the slit was exposed to the red end, and the bottom half to the blue, and so you see two spectra superposed one above the other (Fig. 9). Now we know that in the second order the wave-length of a line will be exactly half that of the wave-length of the next order which is above it. That is to say, suppose the wave-length of the H line to be 3900, the ultra-red ray which lies over it would be exactly 7800, and so on. By these means, by the coincidences of these lines one with the other, one is able to ascertain the exact wave-length of lines which lie in the ultra-red rays of the spectrum.

Then came the question, were we able to separate Draper's lines into bands, and were we able to separate these bands which

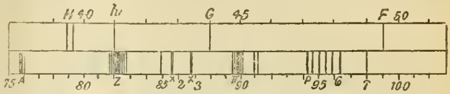

FIG. 9.—Method of determining the wave-lengths in the supra red region.

we photographed into lines? Draper's three lines were separated into 250 distinct lines, and the bands on the screen into somewhere over 500.

Having obtained means of photographing in the ultra-red region of the spectrum, what was the natural use to make of it? To introduce it into the photographic art? Not so, because there were considerations which prevented our doing so; but it seemed that there were other problems which might be settled very readily by recourse to another investigation. It seemed probable that colourless liquids ought to exercise absorption in the ultra-red regions. Nothing was known regarding them beyond the remarkable and well-known experiments made by Prof. Tyndall with a thermopile, with some source of radiation at a comparatively low temperature. He used a red-hot platinum spiral or a cube of hot water, and noted the radiation which was allowed to pass through different liquids and gases. But the knowledge obtained by this method was very much the same as if we were told that so much total visible light was cut off when examining the absorption spectra of coloured bodies. No definite knowledge was obtained as to the parts of the spectrum where the absorption of the liquids took place; in other words, Tyndall gave us a notification of the absorptions, and not their locality—a most important point.

Col. Festing joined with me in investigating this question, and we commenced, as might naturally be expected, by testing the absorption spectrum of water, and then we went on to a variety of hydrocarbons, such as the alcohol series, benzine, and so on. I need not recount to you all the various difficulties we found in our way; they were varied, but ultimately we were able to overcome them. Early in our work we had glimmerings of the truth that subsequently burst upon us in its full and truest light. The method we adopted was as follows:—You may imagine a source of light—the positive pole of the electric light forms a very brilliant source when cast by a lens upon the slit of the photo-spectroscope (Fig. 10). A tube of liquid, T, was placed between

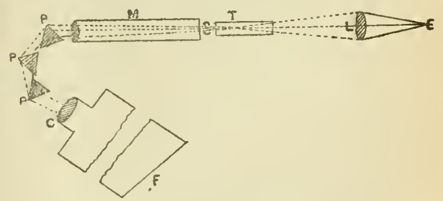

FIG. 10.—Apparatus used in photographing the absorption spectra of liquids.

the lens and the slits: the rays were passed through prisms P, and eventually were received on the photographic plate F such as we have here. Passing sunlight through the top half of the slit, and then using the electric light to get the absorption spectrum of the liquid through the bottom half of the slit, we were able to compare either the solar spectrum with the absorption of the electric light after passing through any liquid; or by placing two different liquids before the top and bottom half of the slit we were able to compare their absorption spectra with each other.

Some of the first results we obtained were with hydrocarbon

containing oxygen. Alcohol and ether are both hydrocarbons—they contain hydrogen, carbon, but also oxygen; and we noticed that in these oxygen compounds these bands of absorption were shaded bands, and not sharp and defined, as it were. We then went on to another series of compounds, or rather, part of the same group which contained no oxygen at all. Thus we worked with methyl iodide, ethyl iodide, and propyl iodide, and we found a very marked difference between the two spectra. We found that in the cases where there was no oxygen there were no shaded bands—that is to say, that if there were bands, they were sharp bands without shading at the sides (Fig. 11). What was the signification of this?

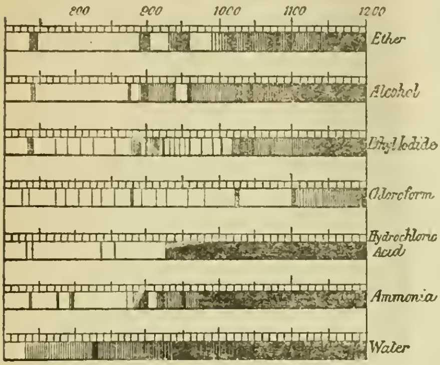

FIG. 11.—Absorption spectra of hydrocarbons, &c.

There must have been some meaning in it. Were the lines or the shaded bands due to carbon or to hydrogen? The lines could not be due to oxygen, because they were not present when oxygen was present. To what, then, could they be due? They must be due to carbon, hydrogen, or iodine; and which of these it became important to ascertain. In Fig. 11 we have a map of a selection of the different alcohols and the iodides, which were photographed. You will see that what I have said about alcohol is correct; that we have the shading off of the bands in the case of the alcohols. But when we come to the iodides we have a marked difference; we have lines springing up, as in ethyl iodide—distinct lines—which are also found in the other iodides. The question then was to trace these lines to their origin. If they were due to carbon we ought, of course, only to find them in carbon compounds; if they were due to hydrogen we ought only to find them where there was hydrogen. So we tried a series of substances, the absorptions of which I throw on the screen. When we tried chloroform, which contains only one atom of carbon and one of hydrogen, but three of chlorine, the whole spectrum became one of lines, nothing else but lines. These lines might be due to the carbon and hydrogen, or they might be due to the chlorine; so the next substance we tried was hydrochloric acid, which contains only hydrogen and chlorine. Here we have lines again which were coincident with some of the lines in the chloroform: those lines might still be due to hydrogen or chlorine. The next substance we tried was ammonia, which contains no chlorine, but three atoms of hydrogen and one of nitrogen. That gave lines again. We next tried carbon disulphide and carbon tetrachloride which contain neither hydrogen nor oxygen, with the result that we had neither bands nor lines. Evidently we had tracked the lines to their source; they were due to the oscillation of hydrogen in these particular compounds we had examined. When we took sulphuric acid we found the same result again; the bands were rather shaded, and to a certain extent it was the same in water also. The oxygen, as we shall see, formed these bands, but at the same time at the limit of the bands a distinct line was formed. Thus then we found in all the absorption spectra which contained lines, that those lines were due to hydrogen and nothing else.

I should next like to show you the further information we gained from these photographs. In the diagram we have the alcohol absorption spectrum, with a chloroform spectrum beneath it. The question to be answered is—Why should we have bands with sharp edges and fine lines in one case, and bands with sharp edges and bands shaded off in the other? In both cases the bands with sharp edges seem to be due to the base of the compound. Thus, in the case of the chloroform, the thick line or sharp-edged band seems to be due to the combination between carbon and hydrogen, and those other lines seem to be due to the vibration of hydrogen and nothing else.

What was the meaning however of the shaded bands as (say) in alcohol? When we came to the photographs it was found without exception that hydrocarbons containing oxygen, when not contained in the radical or base of the compound, always gave some shaded bands, and on measurement it was found that the shading always stopped at points where, in other spectra, we had marked the hydrogen lines. This coincidence was very remarkable, and could not be fortuitous; in fact, it seemed that there must be some connection between the position of these lines and the termination of the bands. The bands must be due to the oxygen in the compounds. What we eventually arrived at at last was this, that the oxygen blotted out the spectrum between two hydrogen lines; that is to say, if you look at it in one way, the oxygen oscillated between two hydrogen lines and cut out that particular portion of the spectrum. When we came to the benzine series, or in fact any other series, we found the same hold good: where we had hydrogen and no oxygen we had lines; where we had oxygen with the hydrogen we had bands. Where we had carbon, hydrogen, and oxygen, you see we had a shaded band and few lines; where we had carbon, hydrogen, and chlorine, or carbon, hydrogen, and bromine, or carbon, hydrogen, and iodine, or carbon and hydrogen alone, we had sharp-edged bands and many lines. Where we had carbon and chlorine, or carbon and nitrogen, or carbon and sulphur, we had no absorption whatever. That is to say, if you place bisulphide of carbon or cyanogen before the slit in one of these tubes we shall see no absorption take place except a general absorption. In other words, the absorption gradually increased and mounted up from the least refrangible end of the spectrum towards the blue end of the spectrum, and that was the only absorption which could be traced. The following table concisely shows the above:—

Carbon, Hydrogen, and Oxygen	Shaded band spectrum and few lines.
Carbon, Hydrogen, and Chlorine Carbon, Hydrogen, and Bromine Carbon, Hydrogen, and Iodine... Carbon and Hydrogen	Sharp-edged bands and many lines.
Carbon and Chlorine ... ... Carbon and Nitrogen ... ... Carbon and Sulphur	No special absorption.
Hydrogen and Oxygen	Bands and lines.
Hydrogen and Chlorine	Lines only.
Hydrogen and Nitrogen	Lines only.

The character of absorption then was general and special. Where we had special absorption bands they were due primarily to hydrogen *atoms* vibrating; whilst the general absorption was due to the *molecules*; the heavier the molecule the more it let the ultra-red through the spectrum. If bases of two series were present we found the absorption due to each base of these particular compounds present in the spectrum. Thus, by taking the absorption spectrum of, say, a compound of ethyl and benzine, we are able to say that the ethyl base was there and the benzine base was there also; the bases of these particular series being denoted by these thicker bands with sharp edges to which I have already referred.

Thus then spectrum analysis opened a way for the chemical analysis of these organic compounds, not of course in their entirety, but so as to get a qualitative idea of what they may contain.

The length of liquid generally employed was six inches, and the natural question to ask is, What is the difference caused by increasing or diminishing the thickness of the liquid between the slit and the source of light? If you increase the thickness of the liquid between the slit and the source of light, it is this: Where you have oxygen bands you have them shaded off; increasing in intensity, but spreading further—they do not spread further in a nondescript way, but in a very marked manner they spread out to the next hydrogen line, and so on. Therefore, supposing with a very small thickness we have oxygen bands extending between two hydrogen lines, in the next six inches of liquid the

absorption will cover three hydrogen lines, and so on. Where you have lines, the lines never alter; where you have those base bands, or radicle bands, as they are called, they never alter; they are always in the same position, and never spread out or diminish either to the right or left. When you diminish the thickness of the fluid those bands are always present, and they are the last things to disappear in the absorption spectra.

Another remarkable thing with regard to these compounds is, as a rule there are two bands which are characteristic of their base. There is a band which is nearly always situated near the limit of the red, and another between wave-lengths 8000 to 11,000. That is to say, there is always a band to be seen somewhere about "a," and another somewhere about ρ. Those are characteristic of any particular compound we may have present.

You may say that I have been giving you a lecture on chemistry but in reality it is one which I hope may lead to results in solar physics. And I now venture to tell you how (Fig. 12). Here

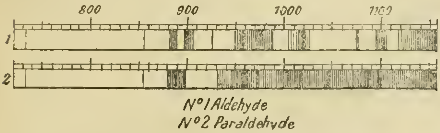

FIG. 12.—Absorption spectra of aldehyde and par-aldehyde.

is a pair of bodies which we examined, to which I wish to draw your particular attention, namely, the spectra of aldehyde and par-aldehyde. Now aldehyde and par aldehyde are the same bodies exactly in composition, only chemists tell us that par-aldehyde has three molecules of aldehyde in its one molecule—the only difference then between them is that there are three molecules of aldehyde combined to form par-aldehyde; aldehyde of course being one molecule by itself. Not only do chemists tell us that this is the case, but they know it, because if they heat par-aldehyde they get aldehyde formed again, and can reconvert this into par-aldehyde. Now I want you to notice the difference in the spectra between these two bodies. We have two bodies of the same chemical composition and of different molecular grouping, and you will see there is a total distinction in the two absorption spectra they yield. The only thing in common is the radical band. There may be one or two other coincidences, but all the rest of the spectra are perfectly distinct. Now if you refer back to Mr. Lockyer's lectures I think this alone will throw some light on what he has already said to you. He has told you, for instance, that the spectrum of iron in the flames and the spectrum of iron in the

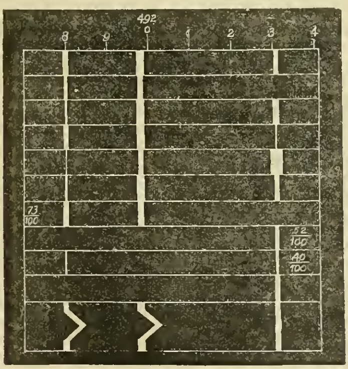

FIG. 13.—[illegible] three iron lines as observed by Lockyer.

spots are dissimilar; and he has kindly furnished me with a photograph which shows one little part of the spectrum in which this is exemplified in a remarkable degree. In it we have three iron lines close to one another (Fig. 13). In the sun-spots two of those only appear, and in the flames the third alone appears. If you look at this by the light of that photograph of aldehyde and par-aldehyde which I had on the screen, I think it is a reasonable deduction to make that the iron in the flame and that in the sun-spots have different molecular groupings. I say that this spectral analysis to which we have subjected aldehyde and par-aldehyde, and many other similarly constituted bodies, lends confirmation to that view. Of course, in the case of organic compounds, we can appeal to the chemist to analyse them for us, and he tells us that they are different molecular groupings. It is scarcely fair in one case to admit that the two spectra are given by two molecular groupings of the same substance, and in the other to deny it.

Again, we found that many lines were common to each hydrocarbon: thus we found a line at 867 of the scale, common to benzine and to alcohol; and to take one particular case, we found a special line common to water, hydrochloric acid, and chloroform. Has this any bearing on what you have heard? Mr. Lockyer has told you that some short lines are to be found in two, three, four, or even six different metals, not taking the long lines into account, as they might be considered to be due to impurities in the different spectra. Let us apply this to our case. A certain substance, A, has certain lines coincident with B; B also has certain lines coincident with C; and C also has other lines coincident with A. Now we will suppose these hydrocarbons were looked upon as elements, but that eventually the chemists split up what they considered elements, and found that the only substance which was common to the three was hydrogen. I leave you to draw the parallel between Mr. Lockyer's experiments and those which I have endeavoured, in a very rough and unsatisfactory manner, to bring before you. I think, if the chemist will admit that in the case of the hydrocarbons it is hydrogen which produces the lines common to all, there is no reason on earth, supposing the metals are not elements, why you should conceive that they should not have a common constituent in the same way that the organic compounds have a common constituent in the shape of hydrogen. I leave that for your consideration.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—Among the professorial notices of next term's lectures already published are those of the Professors of Astronomy, Geology, Botany, and Medicine.

Prof. Pritchard will give three courses at the University Observatory. He will lecture on the Lunar and planetary Theories, and will form two classes for practical instruction in the evenings. Prof. Prestwich will lecture on Stratigraphical Geology in the University Museum. Prof. Lawson will lecture on the Elements of Systematic Botany at the Botanic Garden.

The Professor of Medicine, Dr. Acland, gives notice that the next examination for a Radcliffe Travelling Fellowship will commence in the second week of February. Candidates are requested to communicate with the Professor.

The professors and lecturers engaged in teaching Physics have settled a combined system of lectures for next term as below:—

Hydromechanics, by Prof. Price; (1) Distribution of Terrestrial Magnetism, (2) Electricity developed by Contact of different Substances, by Prof. Clifton; Instruments and Methods employed in Optical Measurements, by Prof. Clifton; Practical Physics, by Prof. Clifton, Mr. Stocker, Mr. Heaton; The Generation and Measurement of Electric Currents, by Mr. Baynes; Electrostatics (treated Mathematically), by Mr. Hayes; Elementary Mechanics (treated Experimentally), by Mr. Stocker; Problems in Elementary Mechanics and Physics, by Mr. Heaton; Elementary Physics treated Experimentally (Heat and Light), by Mr. Dixon. The lectures on Optical Instruments are intended to serve as an introduction to the practical work in the laboratory. The last three courses of lectures are intended to meet the requirements of candidates for the Preliminary Honour Examination.

An examination for a Fellowship in biological subjects will be held at University College in February, 1882, beginning on Wednesday, February 22, at 9 a.m. Candidates are desired to call on Mr. C. J. Faulkner with the usual testimonials and certificates on Tuesday, February 21, between 5 and 6 p.m. But intending candidates are desired to send in their names to him before February 1, 1882, with a list of the subjects which they offer for examination, and at the same time to mention any branch of biology to which they have turned special

attention, or on which they may have written original articles. Copies of any such articles should also be sent in. The examination will comprise (A) Papers of Questions, and (B) Practical Work, in Zoology, Physiology, and Botany. Further and more detailed information may be obtained of Mr. Faulkner.

CAMBRIDGE.—Prof. Stuart has received the offer of an engine from Dr. Siemens for his class-rooms of mechanism. The extension of the workshops is to be proceeded with at once.

Practical anatomy will commence next term on January 20. Demonstrations on Heat, by Mr. Glazebrook, and Electricity and Magnetism (advanced), by Mr. Shaw, will be given next term in the Cavendish Laboratory.

Mr. Garnett will give elementary lectures on Heat in St. John's College, beginning February 2, adapted to the 1st M.B., the Special Examination in Mechanism and Applied Science, and the first part of the Natural Sciences Tripos.

GLASGOW.—The Clark Fellowship in Natural Science (225*l.* per annum for three years) has just been awarded to Mr. John H. Fullarton, M.A., B.Sc.

SOCIETIES AND ACADEMIES

LONDON

Chemical Society, December 15.—Prof. Roscoe, president in the chair.—The following papers were read:—On some higher oxides of manganese and their hydrates, by W. H. Veley.—On a new alkaloid from Cinchona bark, by D. Howard and J. Hodgkin. The authors have extracted from the bark of China Cupræa an alkaloid closely resembling quinine in its general properties. It differs in the solubility of its salts; and from the readiness with which the alkaloid crystallises from ether; they have named it homoquinine. In the discussion which followed this paper Mr. Cownley mentioned that he, in conjunction with Dr. Paul, had separated apparently the same alkaloid, and that the results would be published in the next number of the *Pharmaceutical Journal*.—Contributions to the chemistry of the rare earth metals, by B. Brauner. This paper gives an account of a most thorough investigation of some compounds of cerium and didymium, and the determination of the atomic weight of lanthanum. The author has prepared a tetrafluoride of cerium and a pentoxide of didymium; he places these metals in the eighth series (horizontal) of Mendeljeff's system, thus: Cæsium 133, barium 137, lanthanum 139, cerium 141·6, didymium 146·6.

Royal Horticultural Society, December 12.—Lilies attacked by larvæ of *Brachycerus*, sp.: Mr. Maclachlan exhibited larvæ received from Mr. G. F. Wilson of Weybridge, which eat into the centre of the bulbs of lilies.—Cocoanut attacked by larvæ of *Hylocætus*, sp. The same gentleman also showed some remarkable larvæ with a curiously indurated joint below the head. The species, he observed, was remarkable in penetrating the soft wood of palms, as the European species attacks hard wood, such as firs. He had met with the latter in the Black Forest.—Proliferous fir cone: Dr. M. T. Masters exhibited a cone of *Abies Douglasii*, in which the bracts were foliaceous, but the seed-scale partially atrophied, as is usually the case in proliferous cones. He contrasted this with a proliferous state of *Sciadopitys verticillata* (see Veitch's "Manual of Coniferæ," Fig. 46), in which the seed-scale became foliaceous, the bract remaining normal. The importance of this latter specimen in relation to the nature of the so-called leaves of *Sciadopitys* and of the seed-scale of the Abietineæ was commented on.—Embryo-bud of oak; Mr. W. G. Smith exhibited a specimen about one and a half inches in diameter. It was removed from beneath the bark. Such are extremely common in beeches, in which they vary from the size of peas to that of one's fist.

Society of Telegraph Engineers and of Electricians, December 15.—Annual general meeting.—The following gentlemen were elected as the council of the Society for the ensuing year:—President, Lieut.-Col. C. E. Webber, R.E.; Vice-presidents:—Willoughby Smith, Prof. W. G. Adams, F.R.S., C. E. Spagnoletti, M. Inst., C.E., Prof. D. E. Hughes, F.R.S., Hon. Treasurer, E. Graves; Hon. Secretary, Lieut.-Col. Frank Bolton; Council: W. S. Andrews, William T. Ansell, Sir Charles Bright, M. Inst. C.E., C. B. Bright, the Earl of Crawford and Balcarres, F.R.S., H. G. Ericksen, H. C. Forde, M. Inst. C.E., Matthew Gray, John Fletcher Moulton, F.R.S., Alexander Siemens, Augustus Stroh, C. F. Varley, F.R.S.; Associate Members of Council: Capt. J. T. Bucknill, R.E., C. H. B. Palen, T. R. Crompton, M. Inst. C.E.

EDINBURGH

Royal Society, December 5.—The Right Hon. Lord Moncreiff, president, in the chair.—After a few introductory remarks, the president proceeded to read the obituary notices of Dr. J. Hill Burton, Dr. Andrew Wood, Prof. Sanders, Dr. Handyside, and the Rev. Dr. Cumming.—A quaternion paper on Hamilton's symbolical cubic, by Dr. Gustav Plarr, was presented by Prof. Tait, who then made an interesting communication on the subject of Mirage. By means of a simple assumption as to the law of variation of density in a stratum of air near the earth's surface, a complete explanation could be given of the very curious erect, inverted, and again erect images which were observed by Vince towards the end of last century, and formed the subject of the Bakerian Lecture of 1799. The necessary geometric conditions fulfilled by contiguous rays so as to give either an erect or an inverted image are well known; but no attempt had been made to imagine a simple state of affairs which would give *both* images at once. If the refractive index of a portion of a medium is given by the equation $\mu^2 = a^2 + y^2$, where y is the distance of the portion considered from a given plane—the plane, namely, of minimum density, then it can be easily shown by Hamilton's general method that the path of any ray which is deflected without touching the plane of minimum density is a distorted inverted catenary, and is obviously symmetrical with respect to a vertical line through its vertex. Whatever the law of density, the upper of two such contiguous rays emanating from a given point must in general have its vertex either a little behind or a little in front of that of the lower ray. In the former case the rays *cross* before they return to the same level from which they started, and an inverted image is the consequence; in the latter case they do not cross, and the result is an erect image. Hence the mere inspection of the locus of vertices of all possible rays coming from a given point is enough to tell the kind of image seen by any given pencil of rays belonging to the system. Also all rays that pass between any two given points on the same level must have their vertices on the vertical line half way between these points. If then the locus of vertices is such that it can be cut in three distinct points by a vertical straight line, evidently three images will be possible, two direct and one inverted, precisely as seen by Vince. That under certain circumstances the locus is of this nature can easily be demonstrated. It is not essential that the alteration of refractive index should extend through a large stratum of air; indeed the supposition that it holds only through a limited stratum, and that below the air may be of practically uniform density, gives results much more in accordance with what has been observed in nature.

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THURSDAY, DECEMBER 29, 1881

SUICIDE

Suicide; an Essay on Comparative Moral Statistics. By Henry Morselli, M.D., Professor of Psychological Medicine in Royal University, Turin, &c. International Science Series, Vol. xxxvi. (London: C. Kegan Paul and Co., 1881.)

THIS work enters the International Science Series as an abridged translation of the author's original book, which was written in Italian. As its title implies, it is throughout statistical, and as no pains have been spared in collecting statistics from every available quarter, the results are the most comprehensive and complete that can be obtained with reference to the subject of which the essay treats. These results are interesting, not only because of the light which they shed upon a somewhat sombre topic, but also because they show what a powerful and trustworthy instrument of inquiry we possess in the statistical method, even when applied to what at first sight might appear the most complex and variable of causes leading to the most uncertain or least calculable of effects. For assuredly the most striking feature common to all the multitudinous tables which Dr. Morselli presents to us is the uniformity with which, under a given set of conditions and over a sufficiently wide area of observation, a certain average number of suicides will occur.

Chapter I. is on "The Increase and Regularity of Suicide in Civilised Countries," and it shows that, to use the words of its opening sentence, "from statistics collected up to this time is demonstrated this most painful fact, that suicide has increased from the beginning of the century, and goes on continually increasing in almost all the civilised countries of Europe and of the New World." Thus, for instance, in France from 1827 to 1852 there was a continued increase in the annual number of suicides, from 48·0 to 82·6 per million of inhabitants; and in Italy from 1864 to 1877 there was a similarly gradual rise from 29·2 to 40·6.

Of the "influences which act upon suicide," the first that are considered are the "cosmico-natural." Concerning climate it is shown that "the South of Europe gives the minimum proportion, while that rises by degrees as the centre is approached, reaching a maximum at 50° of latitude, and again gradually declining northwards; "whence it appears that the zone in which are situated the countries where suicide is most frequent is the *temperate*, as might be anticipated from the historical fact of the favourable development of ancient and modern civilisation in the regions furthest removed from the extreme climates." As shown graphically by a shaded map, "the line of suicide crosses the European continent from the north-east to the south-west."

The distribution of suicide in each of the chief countries of Europe is then given. Of the statistics on this head we may quote those which have reference to our own country.

"In Great Britain the average, lowest in Ireland, higher in Scotland and Wales, becomes still more elevated in the North of England, and it acquires its maximum in the South; nor can it be said that this is caused by the

metropolis, as it was in France by the irradiation of Paris, because London, on the contrary, gives a smaller proportion of suicides than some of the South and Southwest counties, and especially Cumberland. We give in Table VII. the averages of the five years 1872-76 calculated on the population of the census of 1871.

TABLE VII.—*Distribution of Suicide in England-Wales (1872-76)*

Divisions and Counties.	Annual average.	In the million.
I. London.		
Middlesex	199·4	88·6
Surrey	63·2	85·1
Kent	16·4	72·6
II. South-east.		
1. Surrey	33·0	90·3
2. Kent	55·0	87·4
3. Sussex	47·0	111·6
4. Hampshire	32·8	62·3
5. Berkshire	17·2	76·0
III. Central-south.		
6. Middlesex	26·2	98·9
7. Hertford	10·4	53·4
8. Buckingbam ...	9·6	61·9
9. Oxford	11·4	63·9
10. Northampton ...	18·0	72·5
11. Huntingdon... ...	3·2	50·5
12. Bedford	5·8	38·2
13. Cambridge	12·2	63·5
IV. East.		
14. Essex	27·6	62·6
15. Suffolk	22·6	65·0
16. Norfolk	33·2	77·0
V. South west.		
17. Wiltshire	11·6	47·4
18. Dorsetshire	9·6	50·7
19. Devonshire	38·0	62·6
20. Cornwall	13·8	38·5
21. Somerset	32·0	66·3
VI. Central-west.		
22. Gloucester	29·0	59·5
23. Hereford	8·0	66·1
24. Shropshire... ...	15·8	59·1
25. Stafford	43·0	49·1
26. Worcester	21·2	62·0
27. Warwick	58·2	92·3
VII. Central north.		
28. Leicestershire ...	23·0	83·2
29. Rut and	3·6	153·9
30. Lincoln	29·4	68·6
31. Nottingham ...	29·0	81·6
32. Derbysbire... ...	27·4	84·3
VIII. North-west.		
33. Cheshire	38·0	70·3
34. Lancashire... ...	197·4	69·2
IX. York.		
35. West-Riding ...	133·4	71·4
36. East-Riding ...	26·4	86·1
37. North-Riding ...	16·4	54·2
X. North.		
38. Durham	37·2	53·6
39. Northumberland.	27·2	70·3
40. Cumberland ...	21·2	96·2
41. Westmoreland ...	3·8	58·3
XI. Welsh.		
42. Monmouthshire...	10·2	46·4
43. South Wales ...	33·6	43·8
44. North Wales ...	16·0	36·7

Why Cumberland, Sussex, Surrey, Warwick, and most of all Rutland, should show such pre-eminence is unaccountable.

Other things equal, the most favourable localities for suicide are flat plains and the courses of large rivers, while mountainous districts invariably yield the smallest percentage. Again, "the regions where suicide predominates are all those formed by alluvial deposits of the more recent epochs; regions, that is to say, which up to the Tertiary period had remained covered by the sea, and which, emerging only in later times, assisted the development of the more recent flora and fauna."

Concerning the influence of seasons, it is shown that—

"The transition period between spring and summer, and especially the month of June, exercises the most positive influence on suicidal tendency, whilst that of winter, particularly of December, would be negative. It is strange that for long an opposite opinion was held; it was maintained that suicide was more frequent in damp, cloudy, and dark weather, such as helps the development of the melancholy passions."

On this subject Dr. Morselli observes that the regular distribution of voluntary deaths in the course of the year, which, taking the chief countries of Europe, he graphically represents by means of curves, "is in evident relation with that of madness. All alienists are agreed as to the greater frequency of mental alienation in the summer season, and this law is confirmed by all the statistics of the asylums for the insane." But—

TABLE XIII.—*Synopsis of the Ethnological differences of Suicide*

	Races and Stocks.	Countries.	Population.	Annual number of suicides.	Per million.	General average.
Germanic Peoples	Scandinavia.	Denmark (1866-75)	1 784.741	468	268	127·8
		Norway (1866-73)	1,741,621	131	745	
		Sweden propr. and Gothia (1866-75)	3 536,799	297	84	
	Germans of the North. (Low-German).	Mecklenburg (1871-75) ...	553,754	95	167	150
		Lauenburg (1858-65)	49.704	8	156	
		Oldenburg (1865-70)	315 995	62	198	
		Prussia and its conquests (1871-75)	25,772.562	3342	133	
		Hamburg (1873-77)	388.618	113	301	
		Bremen (1875-76)	141,848	36	245	
		Ducal Hesse (1871)	852,843	101	160	
	Germans of the South.	Bavaria (1871-76)	5.023.904	450	90	165
		Baden (1871-75)	1.506.531	231	157	
		Würtemberg (1872-76) ...	1,881,505	294	162	
		Kingdom of Saxony (1871-76)	2,760,342	752	299	
		Saxe-Altenburg (1858-65)...	141.839	(42)	303	
		Saxe-Meiningen (1860 61) ..	172.341	(37)	264	
		Salzburg (1873-77)	153.159	19	120	
		Upper Austria (1873-77) ...	736,557	81	110	
		Lower Austria (1873-77) ...	1,990,708	539	254	
		Styria (1873-77)	1,137.990	115	94	
		Carintbia (1873-77)	337.694	34	92	
		Alsace-Lorraine (1856-60)...	1,531,804	230	97	
		Cantons — German-Swiss (1876)...	1.357,424	224	165	
	Anglo-Saxon.	England (excluding Wales) (1872-76)	21 290,596	1538	72	70
		United States of America...	38,000,000	—	(32)	
		South Australian Colonies (1872-76)	208.950	19	90	
	Flemings.	Netherlands (1869-72) ...	3.618.016	140	35	50
		Flemish Prov. of Belgium..	1,342,297	98	74	
		Circ. d'Aurich of Hanov. (1871)...	195.394	—	(100)	
Celto-Romans (Latins?)	Celts.	Wales (1872-76)	1,421,670	60	52	30
		Scotland	3.360,000	—	35	
		Britain (1872-76)	2,947.348	221	75	
		Ireland (1831-41)...	7.800,000	79	10	
	Celto-Romans.	France (1871-75)	36,102,291	5256	150	116
		French Prov. of Belgium (1858-60)	3.433,000	119	35	
		French Swiss Cantons (1876)	1,401,420	284	200	
		Northern Italy (Cisalp.) (1864-76)	11,813.515	500	46	
	Western Romans.	Peninsular and Lower Italy	14.248,157	381	26	27
		Spain (1866-70)	16,302,625	—	17	
		Italian-Swiss Cantons ...	211.401	21	90	
	Eastern Romans.	Transylvania (1873-77) ...	2,115,124	—	80	(50 ?)
		Roumenia	4,000,000	—	(25)	
Slavs	Slavs of the North-West.	Russia (1875)	69,354.541	1771	30	42
		Bohemia (1873-77)	5,140.544	863	158	
		Moravia (1873-77)	2,017,274	289	136	
		Galicia-Buckovina (1873 77)	5,958,083	589	98	
	Slavs of the South.	Carniola (1873-77)	466,334	22	46	30
		Croatia and Slavonia (1864-65)	876,009	—	30	
		Dalmatia (1860-61)	456,961	—	14	
		Military Frontiers (1860 61)	593,232	—	31	
Ural-Alt	Magyars ...	Hungary (1864-65)	9.900,785	—	52	52
	Finns and Letts.	Finland (1869-76)	1,732,621	56	31	40
		Norrland (1861-70)	529,128	31	62	
		Russian Baltic Prov.	3,637,000	—	(41)	
	Slavo-Mongols.	South-East Russia or Caspia	—	—	(51)	(51)

"It is to be noted that suicide and madness ***are not influenced so much by the intense heat of the advanced summer season as by the early spring and summer, which seize upon the organism not yet acclimatised and still under the influence of the cold season.*** And this also applies to the first cold weather, as may be seen in the proportional figures of our statistical tables, perhaps better still in the second elevation, which all the curves, as shown by us, offer in the autumn months of October and November, when the change from the warm to the cold season is more severely felt by the human constitution, and especially by the nervous system."

It is a curious fact that everywhere suicides are committed with greater frequency during the first third of any given month than during the second third, and during the second third than during the remaining third. Moreover of the first third, the first two days yield the largest proportional number. "From whence this fact proceeds is not clear, unless it be that in the first days of each month debauchery, dissipation, orgies, especially in large cities, are more numerous."

Again, among men the first days of the week predominate in respect of influences leading to suicide over the later—the order standing Tuesday, Thursday, Monday, Wednesday, Friday, Sunday, Saturday. Among women, however, an inverse ratio obtains—the order here being Sunday, Friday, Thursday, Wednesday, Tuesday, Saturday, Monday. Doubtless the reason of this among men is that Saturday is usually pay-day, and "thus a day of joy, of material well-being, of moral quiet." This lasts through Sunday, but with Monday men's labour begins, with the after effects of satiated gluttony, inebriety, &c. On the other hand, "the high proportion [of suicides] among women on Sunday is of the greatest psychological interest."

As regards the time of day, the hourly distribution of suicides—

"Is parallel to activity in business, to occupations and work, in short with the noise which characterises the life of modern society, and not with silence, quiet, and isolation. Petit and De Boismont then justly note that the influence of the diurnal hours is shown also in the predominance of those months which have the longest days, and are precisely, as we see, June, May, and July. Thus all the influences which we are studying join together and mingle in one single and efficient synthesis, that is to say, the dependence of man upon nature."

One of the most interesting chapters in the book is that on "Ethnic Influences," a general summary of which is given in the appended table.

On this it is remarked :—

"The low position in point of numbers held by the English peoples, with regard to suicides, in comparison with the Germanic, whilst the first place in the civilised world as regards power and riches belongs to them without dispute, is astonishing; it is not modern Rome, it is not England, which gives the greater number of suicides."

And the divergence between England and the countries where the Celtic race remains most pure (Scotland, Ireland, Wales), proves "the influence of the Germanic element infiltrated"—the Celtic races being least addicted to suicide, and the Germanic most so.

Another very interesting section is that on religious influences. The Jews display "an habitual resistance to suicide, though the same cannot be said with regard to madness." Again, "the Catholic nations, Italy, Spain, and Portugal, stand on the last step of the scale of suicide, whilst those exclusively or mostly Protestant, take the first grade; it suffices to cite Saxony, Denmark, Scandinavia, and Prussia. In countries of mixed religions, the inclination towards suicide diminishes in direct ratio to the predominance of Catholicism . . . the most frequent order in which the various religions follow each other is thus: *Protestants, Catholics, Jews;* and the next in order of frequency come *Protestants, Jews, Catholics.*"

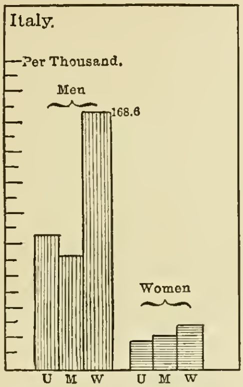
In this connection the following is perhaps worth quoting :—

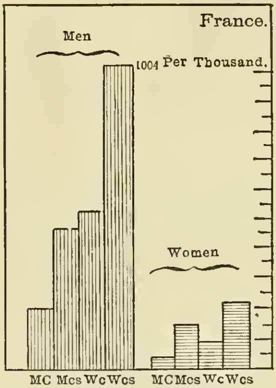
"The very high average of suicides among Protestants is another fact too general to escape being ascribed to

the influence of religion. Protestantism, denying all materialism in external worship and encouraging free inquiry into dogmas and creeds, is an eminently mystic religion, tending to develop the reflective powers of the mind and to exaggerate the inward struggles of the conscience. This exercise of the thinking organs which, when they are weak by nature, is always damaging, renders them yet more sensible and susceptible of morbid impressions. Protestantism in the German States further exercises this exciting influence on the cerebral functions in yet another manner; it originated those philosophical systems which are based on the naturalistic conception of human existence, and put forward the view that the life of the individual is but a simple function of a great whole. These philosophical ideas are harmless enough to strong minds and those stored with a fit provision of scientific culture, but in the democratic atmosphere of our times the heart is not educated *pari passu*. The religious apathy with which the present generation is afflicted does not arise from a reasoned inquiry into the laws of nature or a scientific appreciation of its phenomena; it is not in short a deep conviction of the mind, but springs from a physical inertia and from the little hold obtained by any ideas but such as are directed to material improvement and the gratification of ambition. To our mind therefore the great number of suicides is to be attributed to the state of compromise which the human mind occupies at the present time between the metaphysical and the positivist phase of civilisation, and as this transition is more active in countries of marked mystic and metaphysical tendencies, such as is the case with Protestantism, it is natural that in them suicide should have the greatest number of victims."

Another feature of interest which a comparison of the statistics of all countries brings out is that "it is those countries which possess a higher standard of general culture which furnish the larger contingent of voluntary deaths,"—a fact which finds its curious expression in the following:—"The scale of these countries according to suicide is nearly the same as that of the periodical press." It is likewise higher in towns than amongst the more scattered inhabitants of the country.

Concerning sex, "in every country the proportion is one woman to three or four men, as in crime it is also one to four or five"—a proportion which the tables show to be everywhere maintained with wonderful constancy, save in a few cases, the most remarkable of which is that of





Spain, where "one woman commits suicide against only two and a half men." This strong tendency towards suicide shown by the women of Spain our author attributes "to the force of their passions, which brings them nearer to the male sex."

In both sexes the suicidal tendency augments in direct ratio with age up to the fifth decennial period for men, and up to the fourth for women, beyond which they diminish with as much uniformity. In England, however, the number of young women who commit suicide between fifteen and twenty years is so large as to exceed by more than a tenth the number of men. This "precocity of suicide in English women lasts up to the thirtieth year, when the proportional relation between the two sexes becomes nearly equal to the average. The masculine excess also seems to diminish in extreme old age, so that at above seventy the two sexes tend to draw near again." But—

"The diminution in the last period of life is much more irregular than in all the other conditions: strongest in Würtemberg, less so in Sweden, Belgium, and England; very weak in France, Bavaria, and Italy; failing almost entirely in Denmark (1835-44), Saxony, Austria, and perhaps Prussia. This diminution of suicide amongst the old belongs to the weakening of their character and to that want of energy natural to the last period of existence, in which man returns almost to childhood, and not having a long future before him, and even if overtaken by misfortune, he prefers to await the natural end of his days. Moreover, the religious sentiment awakens and revives in old age, acting as a curb to the passionate emotions and as a supreme comfort in adversity."

The remarkable effects of marriage, widowhood, and presence or absence of children may be best appreciated by transcribing one of Dr. Morselli's diagrams, where U. means unmarried, M. married, W. widowed, MC. married with children, MCS. married childless, WC. widowed with children, and WCS. widowed childless.

A number of tables are given showing the effects on suicide of different occupations. "First of all are the literary, scientific, journalists, engineers, geometricians, all those, in short, who make the greatest use of their brain power. Next come the military, of whose very high

inclination towards suicide we shall speak in the following section; and then the true professionals, tradespeople, and all those reckoned in the vagrant professions." The statistics with regard to the military are remarkable. Thus in Prussia the average suicide over the whole male population is 394 per million, while in the army it rises to 600 or 620. In Austria the proportion is still higher, viz. 866 per million as against 122 of the civil population, and in the Belgian army the case is nearly as bad. In the English army from 1862-71 the suicidal tendency was more than triple that of the male civilian population. "This tendency, moreover, augmented as time advanced; from 1862-71 it grew from 278 per million to 400, and even reached 569 in 1869. The tendency increases with the sending away the troops from Europe, so that in the kingdom (*at home*) the number is 339 per million, but in the English possessions in India it rises to 468." Of the different sections of the British army members of the cavalry are most addicted to suicide (in one year the percentage among the dragoons being as high as 785 per million), next the artillery, then the infantry, foot-guards, engineers, and lastly the household cavalry.

Analysis of the motives which lead to suicide shows this as a general result:—"In man the manifestation of personal interest rules in [almost] every case, and as only a fourth or fifth of the suicides are committed by women, the already small proportion of those which are due to noble and generous motives becomes still more attenuated."

Concerning the methods and places chosen by suicides,

"Each country certainly has its peculiar predilections, but in the aggregate of the peoples by whom suicide is practised, the rope appears to be chosen before every other instrument, and immediately after that water (both giving 5-10ths to 8-10ths of cases); firearms follow; then those arms which cut or stab; falling from a height is preferred to charcoal and poison; and lastly come all the other means."

Hanging stands in inverse ratio to drowning. For in Italy and other countries where hanging is most rarely resorted to, drowning is most common, while in Russia, where hanging is the favourite mode (four-fifths of all the suicides) drowning is very rare (hardly 6·9 per cent.). Firearms are preferred in the South of Europe and by the military everywhere, while in England poison and throatcutting are most favoured. It is curious that "there is a constant difference between the sexes in falls from heights and crushing under railway trains, the former being proportionally more frequent among women, the latter, on the contrary, much more so amongst men." There are other "sexual divergences" of the same kind, and as showing the combined influence of sex and age we may quote one other passage:—

"Males under 15 years of age choose hanging (86 per cent.), and women choose drowning (71 per cent.); in the ages between 15 and 20 the same predilection of the two sexes continues, but it lessens (hanging amongst males is 72 per cent.; drowning among women 65), and it grows still less between the ages of 20 and 30. With the diminution of the tendency towards hanging, that towards drowning increases amongst the men, the greatest number of deaths by this means falling between the ages of 40 and 50; but in advanced age the old people return to a preference for hanging, even more than children (91 per cent.)."

The book concludes with a short "Synthesis," which leads to the proposition that "Suicide is an effect of the struggle for existence and of human selection [*i.e.* natural selection operating in the human species], which works according to the laws of evolution among civilised people." From the present sketch it will be seen that the work as a whole contains many facts of interest to sociologists, although to the rest of the world its somewhat repulsive details will appear useful only as showing the practically emphatic answer which sundry classes of the community respectively give to the question "Is life worth living?"

GEORGE J. ROMANES

OUR BOOK SHELF

Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Michigan—Indigenous, Naturalised and Adventive. By Chas. F. Wheeler and Erwin F. Smith. (Lansing: George and Co., 1881.)

THIS excellent contribution to the flora of the United States has been compiled at the suggestion of the State Horticultural Society of Michigan. It is prefaced with a list of the various catalogues, from that by Dr. Jno. Wright, embracing 850 species, and published in 1839, to that of Dr. Palmer in 1877. With reference to its flora the Peninsula may be roughly divided into two great divisions—the hard wood and the soft wood-lands—one representing the Appalachian flora, the other the Canadian. The hard-wood country lies south of latitude 43°, and consists of very fertile sand, clay, or loam, mostly cleared of the original forest and largely cultivated. The upper Peninsula has a much colder climate than that of the lower Peninsula, and its flora is in many respects decidedly northern. Pines, fir, cedar, larch, elms, poplars, maples, and birch, are among the principal trees; the proximity of the great lakes exerts a marked influence on equalising the temperature, and the effects thereof are well seen. Trees like *Liriodendron tulipifera*, *Cercis canadensis*, *Gleditschia triacanthos*, *Cornus florida*, and *Morus rubra*, which belong to Ohio and Central Illinois, have crept northward, favoured by the mild influence of the lake winds through the central and western part of the Lower Peninsula often beyond the middle. The flora as detailed shows 1634 species. The composites claim the larger number of species—182—about one-ninth of all. Sedges follow with 176 species; Grasses, 139; Rosaceæ, 61; Leguminosæ, 55; Scrophulariaceæ, 46; Umbelliferæ, 27. Of the 165 species of trees and shrubs about twenty are valuable for their timber. About twenty species of woody and herbaceous native climbers are frequent, and some seem worthy of cultivation. The arrangement followed is that of the fifth edition of "Gray's Manual," and a coloured map of Michigan is annexed.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Pendulum Observations in London

THE reference by the President of the Royal Society in his recent annual address to the subject of contemplated pendulum operations permits me to assume that enough interest exists in those operations to render the offer which I now wish, with your kind assistance, to make, not altogether inopportune. I am now engaged in swinging pendulums, *in London*, under conditions

which enable me to invite any person who may wish to make themselves acquainted with the *modus operandi* by actual inspection, to come and witness the same. The only formality I would impose is the communication of the visitor's card and address, and a few hours' notice, in case the intended visit should promise to be inopportune. To reduce the likelihood of this I would intimate that the regular observations are made (in the present case) within about half an hour before and after the hours of six and twelve, morning, noon, evening, and midnight, during which the attention of the observer may be understood to be entirely preoccupied. At any other hour of the day or night, either I or my assistant will be desirous of explaining to the best of our ability whatever may be needful.

My reasons for making this offer so publicly are, in the first place, entirely scientific. I wish to give those who are curious on the subject a fair opportunity, and I hope to derive information or suggestions from those whose attention is for the time engaged in comprehending the details by means of which the general result is sought to be obtained. Beyond this, I am also desirous of obtaining some indications as to the degree of interest actually existing in England on the subject of gravity-measures of this kind.

The present site has a peculiar interest. It is a cellar which I have been lucky enough to find very near the desired spot—which is that which was occupied in the early part of this century by Kater, Sabine, Foster, and others; but was afterwards necessarily abandoned on the decease of Mr. Browne, of Portland Place, whose house was the *rendezvous* of those observers. It was in consequence of this abandonment that the intention was formed of founding a more permanent central point of reference; and as the establishment of a magnetical observatory at Richmond was at that time under consideration, the transfer of what may be called the English home of pendulum investigations from Portland and Tavistock Places to the new Richmond (or "Kew") Observatory was decided upon, and accordingly when next pendulum experiments were instituted, their site was in the Richmond Observatory. It is only recently, however, that the necessity of ascertaining the physical relation between the two sites has become a practical one.

Something of the same sort had been experienced in the earlier days, when, partly owing to Greenwich Observatory having formed the base or *point d'appui* on English soil, of one or two foreign series of operations; partly because of the obvious anomaly of having the principal English pendulum station in a private house; special observations were instituted for determining the relation of that site to the Greenwich one. Greenwich was thus incorporated on the one hand with those series which depended on the Portland Place site, while the latter was connected with those dependent (if one may use the term where all are mutually dependent) on the Greenwich site. They were all, in fact, to a certain extent linked together.

This should explain why re-observation at Greenwich, in connection with re-observation at Kew, seems likely to meet the present want best if supplemented by re-observation also at, or very near, the old Portland Place site. I have made the requisite observations (subject to some doubt) at Kew, *i.e.* at the Richmond Observatory, and at Greenwich Observatory, and I am now doing the same in the cellar above referred to, as representing Portland Place. Its exact situation is immediately in rear of All Souls' Church, Langham Place.

The Kew (or Richmond) Observatory is not a very convenient place for observations of this nature. They require attendance at all hours, whereas the observatory is situated so far from the inhabited part of Richmond as to permit of such attendance only at great personal inconvenience.[1] Also, though a precise knowledge of time is of the first importance, the absence of telegraphic communication with Greenwich Observatory and the distance from the nearest telegraph station combine at Kew to make one dependent on local transits. This is of itself a very serious objection. If to this we add that the pendulum-room at the Kew Observatory is too small to allow of the introduction of any portable stand or framework such as must of necessity be used on voyages—the very restricted space being permanently occupied by a fixed support, which does not admit of the same dispositions as would be made elsewhere for convenient observations, it remains a serious question whether Kew ought to continue to be regarded as the fundamental English pendulum station. There can be very little doubt, having regard to the paramount importance of *time* in pendulum experiments, that the fundamental station should have a perfect command of that element, such as can rarely be obtained except at a fixed astronomical observatory.

At the Langham Cellar, after due consideration, I have concluded to rely on Greenwich alone for time; sending a chronometer for the purpose every day. So far, the plan seems to be quite satisfactory, being more reliable than noting a transmitted signal at the nearest post-office.

Although I do not think I have touched on any point in this letter which is not closely connected with its primary object, I must nevertheless apologise for its length. In conclusion I have now only to repeat the offer with which I commenced it, that any one interested in, or desirous of becoming practically acquainted with pendulum swinging of this particular kind, may, at any time within the next fortnight, visit and inspect the apparatus in action, by communicating with me, at the address here given. J. HERSCHEL

1, Langham Street, Portland Place, W., December 28

[1] I estimate that I walked fully 200 miles to and from my work, in all weathers and at all hours, while carrying on the observations at Kew in September and October last.

Dante and the Southern Cross

> ". . . vidi quattro stelle
> Non viste mai, fuor ch'alla prima gente."
> *Purg.* i. 23.

No one will accuse me of excessive patriotism when I say that Dante was one of the very few chosen spirits of the fourteenth century who were thoroughly acquainted with all natural phenomena, so far as they were then known and understood, whilst he was perhaps the only one who manifested a decided contempt for all the pretensions of astrologists and necromancers (Inf. xx.). The words of such a man are deserving of the best consideration, alike of literary and scientific men; it is therefore to be hoped that before the discussion ends those best qualified to speak will throw more light on the lines in question.

As yet in answer to the query which appeared in NATURE (vol. xxv. p. 152), we have only had a quotation of a well-known passage from Humboldt's "Cosmos," and the suggestion that Dante must have derived his knowledge of the Southern Cross—evidently indicated in the lines at the head of this note—from Arabian Globes—a suggestion which, by the way, is expressed, or clearly implied, in the "Cosmos," within a page from the passage quoted. As to the remark with which both Mr. Walker and Mr. Wilks end their notes (NATURE, vol. xxv. p. 173) that "prima gente" does not refer to Adam and Eve, but to the early races which inhabited Europe and Asia, though not new, it is obviously correct to the mind of those who know how great was the cosmographic knowledge of Dante. Yet, as Count de St. Robert states in an ably-written pamphlet on the point in question (Torino, 1866), strange to say, Humboldt (who has so unhesitatingly stated the opinion of Dr. Galle that in 52° 30′ north latitude in consequence of the precession of the equinoxes, the Southern Cross might have previously reached more than 10°, and that it began to become invisible in that latitude 2900 years before Christ), believed that "prima gente" referred to our first parents.

Now, whilst admitting as possible that Dante obtained his knowledge of the stars which form the Southern Cross from the catalogue of Ptolemy (Almagest, Book vii.), on reading the passage, in which occur the two lines quoted above, especially in the original, one is irresistibly brought to think that Dante's enthusiastic description of the "quattro stelle" was inspired by the vivid description of a Christian witness of the glorious spectacle. The person most likely to have imparted such knowledge to the great poet was Marco Polo. That celebrated Venetian traveller returned from his last voyage in 1295, and lived in his native town till 1324 (Col. Yule, "The Book of Ser Marco Polo"). Dante did not visit Venice till 1320, after he had finished his "Divina Commedia," but there are many reasons for the belief that the two great men met or corresponded together.

With regard to the lines:—

> ". . . quelle tre facelle,
> Di che 'l polo di qua tutto quanto arde."
> *Purg.* viii. 89.

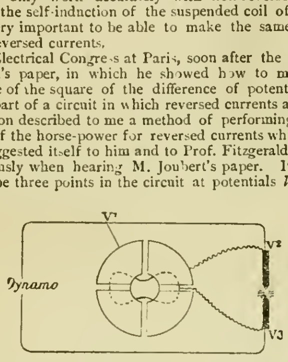
which Dante says were high when the "quattro stelle" were low, it is difficult to agree with any of the commentators, because neither the Magellanic clouds, nor Achernar, nor any three prominent southern stars, correspond satisfactorily to the "tre facelle" alluded to. It must not be forgotten that accurate

astronomical and geographical knowledge is but of recent date, and, as already stated, Dante formed many of his cosmographic conceptions chiefly from hearsay. N. PERINI

The Horse-Power given to any Part of a Circuit by Intermittent Light

SOME time ago, with Prof. Ayrton, I designed and constructed an instrument to measure the horse-power given electrically to any incandescent or arc lamp, or to any part of a circuit, an improvement on the instrument previously devised by M. Deprez; the pointer of a suspended coil moves at once to a mark on a scale which tells the horse-power. The instrument is dead beat, and, what is very important, by a special commutator arrangement it can be calibrated with much smaller forces than it is intended to measure. The current in the suspended coil is proportional to the difference of potential at the ends of a part of the circuit, and the fixed current which causes its deflection is the total main current in the circuit, so that the deflection represents the product of these two factors. The instrument was described at the Society of Arts in March last, and was exhibited at the British Association meeting at York. It will, however, necessarily only work accurately with non-reversed currents because of the self-induction of the suspended coil of fine wire, and it is very important to be able to make the same measurement for reversed currents.

At the Electrical Congress at Paris, soon after the reading of M. Joubert's paper, in which he showed how to measure the mean value of the square of the difference of potential at two ends of a part of a circuit in which reversed currents are flowing, Prof. Ayrton described to me a method of performing the measurement of the horse-power for reversed currents which seemed to have suggested itself to him and to Prof. Fitzgerald of Dublin simultaneously when hearing M. Joubert's paper. It was this: Let there be three points in the circuit at potentials V_1, V_2, V_3,



at any instant, and let there be a known resistance R (with no self-induction) between V_1 and V_2. Let V_3 be connected with the needle of a Thomson's electrometer, and let V_1 and V_2 be connected with the quadrants, V_1 being also connected with the outside of the Leyden jar: then the deflection of the needle measures the mean value of

$$(V_2 - V_1)\left(V_3 - \frac{V_2 + V_1}{2}\right).$$

Now let the needle and a pair of quadrants be connected with V_2, the other pair with V_1, and we measure the mean value of the square of $(V_2 - V_1)$. The difference of these measurements is easily seen to be R times the expended energy which we want to know.

I was not present when Professors Ayrton and Fitzgerald communicated their idea to one another, but immediately afterwards Prof. Ayrton explained it to Sir William Thomson and to me together, making sketches of the necessary connections. Sir William thought well of it, but feared that perhaps the present quadrant electrometer would not be sensitive enough for the measurements. We suggested, however, the use of our multireflex arrangement (see *La Lumière Electrique*, October 5, 1881) for creating greater sensitiveness, and as he was pleased with the idea, we have, since that time, in our very short intervals of leisure, been trying to arrange an electrometer which shall be sensitive enough for the purpose.

I observed to-day that M. Potier in the October number of the *Journal de Physique* publishes the same idea, and I wish to place it on record that the fundamental idea of the new process, which seems to me very feasible and of considerable practical importance, occurred to Messrs. Ayrton, Fitzgerald, and Potier independently. JOHN PERRY

Talgarth Road, West Kensington, December 6

The New Red Star in Cygnus

THE above star, which I found on the 22nd of May last, and which then appeared of the 9th magnitude, and reached 8 m. on June 8, seems now no more than 12 m. Estimations of very small magnitudes are, of course, very difficult, but I believe I am not under the mark in saying 12 m., as I found the star not easy with a 4½ inch O.G. At the same time its deep crimson seemed very striking by glimpses, and in its present state it is, perhaps, the smallest among the stars whose red colour has been observed. It will probably have to be classed among the most remarkable variables. J. BIRMINGHAM

Meteor

TAKING a look at the eclipse of the moon on December 5, about 5.44 p.m., I happened to see a meteor that is, I think, very noteworthy, though, perhaps from distance, its apparent size was so small that I might have scarcely seen it but for the temporary lessening of the light of the moon. Its motion was, throughout its visible course, horizontal and slow. When it met my eyes, it was just below the Pleiades. I followed its flight to the northern end of the eastern sky; there it seemed to go on out of my sight, without fall or collapse: for aught I know, I might have observed it even from the extreme south, had my eyes been turned thither at the outset; I would draw attention to this fact, as well as to its horizontal motion and its seemingly slow progress. The grandeur of the glories displayed by that night's clear sky was at its height as this mysterious stranger passed above our winsome satellite—then a thing of "eerie beauty," its glistening golden ring half-clasping, like "the old moon in the new moon's arms," the earth-shadowed orb over it, and the latter shimmering with the maroon ember-like sheen called by the French *la lumière cendrée*.

JOHN HOSKYNS-ABRAHALL

Combe Vicarage, near Woodstock, December 16

SEA-SICKNESS.—This must be declined as a subject for correspondence.

A NEW ELECTRICAL STORAGE BATTERY[1]

THE great utility of some thoroughly practical method of conserving electric force has caused a great deal of attention to be applied to the subject; no system of electric supply can be considered as perfect until some means is used to so store the force generated that it may be drawn off equally and regularly, and this whether the generator be on or off. If we take, as an example of electric supply, the present systems of electric lighting, it is at once seen, should an accident or stoppage take place in the machinery generating the current, the whole of the apparatus such as lamps or motor-machines are influenced; should there be a reservoir of electricity between the generator and the apparatus of whatever sort for utilising the force this inconvenience would not occur.

All the present systems of storing electricity depend on certain chemical changes produced by electrolysis.

I have gone through a long series of experiments on storing electricity and made many forms of cells, one being a porous pot containing dilute hydric sulphate and a sheet of lead, in an outer vessel containing a sheet of lead in solution of acetate of lead, the plate in the porous pot being made the positive electrode; this cell had the power of storing electricity, by peroxidising the positive electrode, and depositing from the acetate of lead solution metallic lead on the negative electrode, the hydrogen having combined to form acetic acid. On discharging the peroxide is reduced, and the oxide formed during discharge on the other plate dissolves in the acetic acid, forming the original solution of acetate of lead; by this means I eliminated the injurious effects of the hydrogen on charging.

During my experiments I found that red oxide of lead is a very bad conductor of electricity, and the peroxide a good conductor. I also discovered that by amalgamating lead plates with mercury a marked increase was

[1] "On a New Electrical Storage Battery." By Henry Sutton (Ballarat Victoria). Communicated to the Royal Society by the President.

immediately manifest in polarisation effects, the plates becoming more uniformly and rapidly peroxidised when used as positive electrodes, and local action entirely disappearing. These mercury amalgamated plates at once give me an advance of other cells. I used them in many ways, constructing cells in which the positive plate was amalgamated, and the negative coated with red oxide, or with peroxide, produced by treating red oxide with dilute hydric nitrate till the brown precipitate of peroxide fell, the precipitate being washed and painted on the electrode. I also amalgamated the negative electrode simply. I found that in every way positive electrodes amalgamated produced the best results. I also made cells in which either peroxide or red oxide was formed into a porous conglomerate, using the conglomerates as electrodes, immersed in dilute hydric sulphate. I constructed cells with parallel plates, red oxide or peroxide being filled in between the plates; in this experiment red oxide is useless and peroxide efficient. In all these experiments I succeeded in storing electricity to different extents.

Having thoroughly satisfied myself that positive electrodes amalgamated with mercury were the best, I investigated the behaviour of various forms of negative electrode, having in view the conservation of the hydrogen; this I thought to do by occluding the hydrogen in suitable electrodes, as spongy platinum or metallic palladium; but as both these methods would be useless owing to expense I did not even experiment on them.

I further thought of having negative electrodes, whose oxides should be soluble in the solution, and which could be redeposited from the solution, or of having metallic solutions from which metal could be deposited, the resulting solution being such that should, on the oxidation of the deposited metal, combine with the oxide and again form the original solution.

I thought that success in this manner would result in a powerful and constant source of stored energy, the cell would not polarise itself during discharge, as is the case in both Planté and Faure cells; in these cells the peroxide formed by the discharge produces a contrary electromotive force.

Experimenting from this train of thought, the results I have obtained are such as to have an important practical bearing on the future of electric work.

The experiments comprised amalgamated lead as a positive electrode with negative electrodes composed of either zinc, iron, or copper, in each case the solution between the electrodes being a salt of the metal composing the negative electrode. With zinc, sulphate of zinc was the solution; with iron, sulphate of iron; and with copper, sulphate of copper. In all these cases the results were not only far more powerful than with any form of cell I had previously devised, but also very constant, the polarisation lasting many times longer than in any other form of cell. The cell with zinc negative electrode I discarded, owing to the necessity there would be to keep the zinc plate amalgamated to prevent local action; the iron negative electrode was set aside owing to the iron oxidising when the cell was not in use. The cell having a negative electrode of copper, a positive electrode of lead amalgamated with mercury and a solution of cupric sulphate, I have adopted as a thoroughly economical, lasting, and practical form of storage reservoir. The chemical changes in this cell are exceedingly interesting and beautiful, the cell being composed of a sheet of lead cleaned with dilute sulphuric acid and amalgamated thoroughly with mercury, and a sheet of thin copper a little shorter; the two sheets are perforated with a number of holes and then rolled in a spiral, separated by rubber bands cut every five inches, the holes in plates and cuts in rubber bands being to allow free circulation of the solution (the short plate being uppermost before rolling). This combination is immersed in a solution of cupric sulphate, and the amalgamated lead plate made the positive electrode of a suitable source of electricity, the chemical action being that the oxygen of the decomposed solution combines with the lead, forming a perfectly even coating of the insoluble peroxide, the hydrogen replacing the copper of the solution, and the copper being deposited in the metallic state on the negative electrode. As the decomposition of the cupric sulphate proceeds the solution gradually loses its azure blue colour, becoming more acid, and finally when the whole of the copper is deposited, we have the solution colourless and transformed into hydric sulphate and water, the positive electrode peroxidised and copper deposited on the negative electrode. During discharge the peroxide is reduced and the copper element oxidised, the oxide combining with the acid and forming cupric sulphate, the solution returning to its original colour. This change of colour forms a beautiful means of telling when the cell is charged; it is a veritable charging gauge. The power of this cell is very great and very constant; it can be made to last for hours, the time being dependent on the quantity of cupric sulphate decomposed.

I have, by the decomposition and recomposition of one pint of cupric sulphate, obtained over two hours' effective work in heating to a red heat one inch of No. 28 iron wire, the cell measuring internally 4 inches deep and 4 inches diameter.

I constructed cells with free crystals of cupric sulphate suspended in the solution, and found that the presence of free crystals prevented the oxidation of the amalgamated lead electrode, it being essential that the solution become slightly acid before the peroxide will form. The cell during charging gives out a peculiar rattling noise, which I consider due to the deposition of copper on the negative electrode altering the form of the spiral.

A practical form of cell for storing purposes ought to be made, by fixing a series of amalgamated lead plates in a box in grooves, as in Cruikshank's trough battery, filling the interval between the plates with solution of cupric sulphate, and passing a current through of sufficient tension to overcome the contrary electromotive force of the series, the positive sides of the plates being peroxidised and copper deposited on the negative sides. I have two boxes on this plan, each containing twenty-five plates, the total being equivalent to fifty cells. By this means batteries of great tension can be charged from thirty Bunsens. A number of twenty-five plate boxes can be coup ed for quantity of charging, and for tension during discharge. Twenty such boxes, one foot square, internal measurement, will give in series a battery of 500 pairs of one foot square plates.

It will be seen from the foregoing that this method of conserving energy has a wide field before it, and as it will benefit fellow-workers in science, placing in their hands a means of experimenting with powerful electric currents, I give it without reservation, freely and untrammelled by patent rights, for their use.

THE BISCHOFFSHEIM OBSERVATORY

THIS observatory built at the expense of M. R. Bischoffsheim, the member of the French Lower House for Nice, is situated on Mont Gros, at an altitude of about 370 metres, and at a distance of eight English miles on the old Route de la Corniche, so well known and appreciated by the tourists travelling by road from Nice to Genoa. M. Celora, Milan astronomer, Commander Bahet of the French Staff, and M. Perrotin, the present director of the Bischoffsheim Observatory, have ascertained electrically and astronomically, the longitude and latitude of the new establishment which has been connected with Paris and Milan, by unquestionable observations.

The buildings have been constructed under the direct supervision of M. Garnier, the architect of the Paris

Opera, and distributed skilfully in several favourable sites of a large park having a surface of 80 acres.

The smaller meridian circle by Gauthier is in its place, and can be used for daily determinations. The large meridian circle by Brünner will be finished in the first month of 1882. The object glass has 8 inches diameter, and has been focussed to a distance of 10 feet. The smaller equatorial with an object-glass of 14 inches, and focussed to 27 feet, has been made by Eichens, and will be ready for observations at the same time as the larger meridian circle. The larger equatorial will have an object-glass of 28 inches, and will be focussed to 52 feet. The glasses have been made by Feil; Henry Brothers are polishing them. The instrument will be constructed by Eichens and Gauthier The work is proceeding favourably, but it is impossible to state when it will be completed.

M. Lœwy, sub-director of the Paris Observatory, has designed an apparatus for preventing the perturbations produced by the flexion of the axis when observations are taken at a large angular distance from the zenith. The building will have a diameter of sixty-four feet, with a rotating roof of copper, worked by hand-machinery, as designed by Gardiner.

The Bischoffsheim observatory will not be confined to astronomical observations. The donor having been taught by Leverrier in astronomy has felt it a duty to extend his donation to magnetical and meteorological observations, too often neglected in French observatories. A magnetical pavilion has been built with extensive cellars, for continuous self-registering apparatus. The registration takes place by photography as in Kew, and is made with instruments by Adie, the maker of the Kew set of registers. As in Kew, a "rez-de-chaussée" has been built for direct force and direction observations. The instruments have been made by Brunner.

The installation of the meteorological instruments has been made under the direct supervision of M. Mascart, the director of the French Meteorological Office. A constant staff has been selected by M. Bischoffsheim, and is now on duty. The direction has been given to M. Perrotin, formerly assistant astronomer to M. Tisserand when he was director of Toulouse Observatory. The assistant astronomer is M. Carvallo, formerly a pupil in the Polytechnic School, and who has taken his astronomical honours in the special school established by Rear-Admiral Mouchez at the Paris Observatory. M. Puiseux, formerly pupil of the Polytechnic School, will have the control of magnetical and meteorological observations.

Two houses have been built—one for the administration and the other for the direction. The first floor of this staircase has been fitted up entirely for boarding foreign astronomers who are desirous of making observations in this magnificent astronomical "caravanserai." M. and Mdme. Struve and M. Tachini have promised already to spend some time there next winter.

It should be noted that it was probably in a tour made in England with Leverrier, when the great astronomer was made an honorary doctor of Cambridge University, that M. Bischoffsheim meditated on the opportunity of establishing an observatory entirely of his own. Up to that time he had spent his time in the observation of stars which shine in a less elevated sphere than the heavenly skies. But Leverrier's conversation and intimacy led him to appreciate other unfading beauties.

The Bureau des Longitudes has agreed to take possession of the observatory, which will be handed over to it with a sufficient endowment to keep it decently. It is estimated that the money spent in purchasing the estate, &c., will exceed 120,000*l.*, and that the endowment will be more than 2000*l.* a year. This handsome donation must be noted as being a revolution in French generosity towards science. Up to this time our neighbours confined themselves to bequeathing legacies and lavishing posthumous generosities.

FOSSIL FLORA OF SUMATRA[1]

THIS is a paper of some twenty pages and six plates. Herr Verbeek sent in 1874 a small collection of fossil plants from Sumatra to Switzerland, which were described by Heer, and in the following year the second collection, now described, was received, no others having been found in the interval. The plates contain twenty-two figures, most of them representing fragments of simple ovate leaves, supposed, with two exceptions, to be allied to existing species of the Indian mainland or archipelago. The mollusca in the overlying strata point to an Eocene age. The exceptions are a Eucalyptus and a small leaflet ascribed to Cassia, and now represented, it is here supposed, by *C. lævigata* of tropical America, but the determination rests on slender grounds. The majority of them, in fact, though doubtless the best that could be made from such material, must necessarily be almost mere guesses. The value of such guesses may be inferred from a similar work by the same author on the fossil flora of Madeira.

In this case several of the commonest indigenous plants of Madeira were referred to extra-Madeiran plants. For instance, the terminal leaflets of *Rubus discolor* were referred to *Corylus australis*, and various leaflets of *Rubus grandiflora* are figured as *Corylus australis*, *Ulmus suberosa*, and *Psoraleadentata;* the so-called *Pistacea Phæacum* is the common myrtle, the *Ilex Hartingi* is the Madeira *Vaccinium*, and the figures of *Myrica Faya* belong to *Ardisia excelsa*. In this case the mistakes are the more singular, as Prof. Heer had actually sojourned in Madeira, and the plants are the commonest on the island. If with even exceptionally favourable circumstances such mistakes can be made, generalisers should surely be cautious in building theories upon the ages of formations, &c., when they have been determined upon the evidence of fossil plants. It is unfortunate that on evidence as trivial, and even more questionable, we read in Lyell of the MIOCENE outbursts of Mull, of Iceland, and Greenland, of the MIOCENE deposits of Bovey Tracy, &c.

It is important, however, that fossil plants should be figured and described, for if the generic and specific names, except when based on ample material, are regarded merely as an individual opinion, the determinations become of use. Whatever is unsatisfactory in the work is inherent to the subject, for few possess the zeal and untiring industry of Heer. If he would only make clear to his readers the reasons which enable him in his own mind to determine the genus to which an ordinary type of leaf, with neither top nor base, belongs, and would be less positive where nothing positive is possible, his works would acquire a scientific value which some justly think they hardly at present possess.

J. S. G.

THE VOYAGE OF THE "VEGA"[2]

II.

BARON NORDENSKJÖLD frequently refers to what Mr. Leslie renders "self-dead" animals, meaning animals that have died a natural death, in distinction to those that have been killed by hunters or by other animals. The rarity of such "self-dead" animals is remarkable, especially along the north coast of Asia, where there are few hunters and fishers, and where immense numbers of animals must die. While sailing along the Taimur coast, large numbers of dead fish (*Gadus polaris*) were seen lying on a block of ice, and strewed along the bottom of the sea, which Baron Nordenskiöld notices as being very unusual.

[1] By Dr. Oswald Heer (*Neue Denkschriften der schweizerischen Gesellschaft*, vol. xxviii. Zürich, 1881)

[2] "The Voyage of the *Vega* round Asia and Europe; with a Historical Review of previous Journeys along the North Coast of the Old World." By A. E. Nordenskjöld. Translated by Alexander Leslie. Five steel portraits, numerous maps and illustrations. Two vols. (London: Macmillan and Co., 1881.) Continued from p. 183.

"They had probably perished from the same cause, which often kills fish in the river Ob in so great numbers that the water is infected, namely, from a large shoal of fish having been inclosed by ice in a small hole, where the water, when its surface has frozen, could no longer by absorption from the air replace the oxygen consumed, and where the fish have thus been literally drowned. I mention this inconsiderable *find* of some self-dead fish, because self-dead vertebrate animals, even fish, are found exceedingly seldom. Such *finds* therefore deserve to be noted with much greater care than, for instance, the occurrence of animal species in the neighbourhood of places where they have been seen a thousand times before. During my nine expeditions in the Arctic regions, where animal life during summer is so exceedingly abundant, the case just mentioned has been one of the few in which I have found remains of recent vertebrate animals which could be proved to have died a natural death. Near hunting-grounds there are to be seen often enough the remains of reindeer, seals, foxes, or birds that have died from gunshot wounds, but no self-dead Polar bear, seal, walrus, white whale, fox, goose, auk, lemming or other vertebrate. The Polar bear and the reindeer are found there in hundreds, the seal, walrus, and white whale in thousands, and birds in millions.[1] These animals must die a "natural" death in untold numbers. What becomes of their bodies? Of this we have for the present no idea, and yet we have here a problem of immense importance for the answering of a large number of questions concerning the formation of fossiliferous strata. It is strange in any case that on Spitzbergen it is easier to find vertebræ of a gigantic lizard of the Trias, than bones of a self-dead seal, walrus, or bird, and the same also holds good of more southerly inhabited lands."

Another problem of great importance is suggested by the finding of some yellow specks on the snow of the Taimur coast, which turned out to be carbonate of lime of an unusual form of crystallisation, and which the Baron believes were probably of interplanetary origin. He gives a brief sketch of his previous observations in the high north on this subject, referring also to what has been done by M. Tissandier, and during the last English polar expedition, and to the special suitability of the uninhabited Arctic regions for the collection of what is believed to be cosmic dust. It is certainly a subject which deserves the attention of future expeditions, and especially of the polar observing stations which are in a fair way of being established.

"It may appear to many that it is below the dignity of science to concern one's self with so trifling an affair as the fall of a small quantity of dust. But this is by no means the case. For I estimate the quantity of the dust that was found on the ice north of Spitzbergen at from 0·1 to 1 milligram per square metre, and probably the whole fall of dust for the year far exceeded the latter figure. But a milligram on every square metre of the surface of the earth amounts for the whole globe to five hundred million kilograms (say half a million tons)! Such a mass collected year by year during the geological ages, of a duration probably incomprehensible by us, forms too important a factor to be neglected, when the fundamental facts of the geological history of our planet are enumerated. A continuation of these investigations will perhaps show, that our globe has increased gradually from a small beginning to the dimensions it now possesses; that a considerable quantity of the constituents of our sedimentary strata, especially of those that have been deposited in the open sea far from land, are of cosmic origin; and will throw an unexpected light on the origin of the fire-hearths of the volcanoes, and afford a simple explanation of the remarkable resemblance which unmistakably exists between plutonic rocks and meteoric stones."[1]

[1] I can remember only one other instance of finding self-dead vertebrate animals, viz. when in 1873, as has already been stated (p. 110), I found a arge number of dead rotges on the ice at the mouth of Hinloopen Strait.

After leaving Cape Chelyuskin, the *Vega* sailed for a considerable distance over what, in existing maps, is set down as land; and although there was necessarily little time for accurate surveying, still it will be found that the expedition has done much to render accurate the geography of the north coast of Asia. After sailing down the east side of the Taimur Peninsula, close by the land, the vessel was directed almost straight eastwards towards the most southerly of the New Siberian Islands, still keeping as near the coast of the mainland as practicable. Off the delta of the Lena, which within the last week has come so prominently before us in connection with the *Jeannette* expedition, the *Vega* parted with the *Lena*, which entered the river, to establish regular traffic by steamer. It was only after leaving Cape Chelyuskin that ice in any quantity was met with so as to hamper the progress of the vessels, and Baron Nordenskjöld states that had the coast-water been better known so that he could have kept closer to land, the latter part of the voyage would have been as free from obstruction as the former.

Here follows an interesting chapter on the commercial navigation of the great Siberian rivers, and on the geography and economical condition of Siberia. It contains indeed a summary of all that is known to science of the immense country, with much that is the result of Baron Nordenskjöld's own research or observations, and with speculations on geology that are not likely to be let pass unchallenged. The *Lena* had some difficulty in navigating the delta of the river, for the old maps of 140 years ago were useless, the changes at the mouth of the river in that time has been so great. The Baron draws an interesting parallel between Siberia and America north of the 40th parallel.

He then gives a sketch of his own journey up the Yennissi in 1875, in connection with which we give a view on that river (Fig. 7).

"As is the case with all the other Siberian rivers running from south to north,' the western strand of the Yenisej, wherever it is formed of loose, earthy layers, is also quite low and often marshy, while on the other hand the eastern strand consists of a steep bank, ten or twenty metres high, which north of the limit of trees is distributed in a very remarkable way into pyramidal pointed mounds. Numerous shells of crustacea found here, belonging to species which still live in the Polar Sea, show that at least the upper earthy layer of the *tundra* was deposited in a sea resembling that which now washes the north coast of Siberia.

"The *tundra* itself is in summer completely free of snow, but at a limited depth from the surface the ground is continually frozen. At some places the earthy strata alternate with strata of pure, clear ice. It is in these frozen strata that complete carcases of elephants and rhinoceroses have been found, which have been protected from putrefaction for hundreds of thousands of years. Such *finds*, however, are uncommon, but on the other hand single bones from this primeval animal world occur in rich abundance, and along with them masses of old drift-wood, originating from the Mammoth period, known by the Russian natives of Siberia under the distinctive name of 'Noah's wood.' Besides there are to be seen in the most recent layer of the Yenesej *tundra*, considerably north of the present limit of actual trees, large tree-stems with their roots fast in the soil, which show that the limit of trees in the Yenesej region, even during our geological period, went further north than now, perhaps as far as, in consequence of favourable local circumstances, it now goes on the Lena.

"On the slopes of the steep *tundra* bank and in several

[1] Namely, by showing that the principal material of the plutonic and volcanic rocks is of cosmic origin, and that the phenomena of heat, which occur in these layers, depend on chemical changes to which the cosmic sediment, after being covered by thick terrestrial formations, is subjected.

of the *tundra* valleys there is an exceedingly rich vegetation, which already, only 100 kilometres south of Yefremo-Kamen, forms actual thickets of flowering plants, while the *tundra* itself is overgrown with an exceedingly scanty carpet, consisting more of mosses than of grasses. Salices of little height go as far north as Port Dickson (73° 30′ N.L.), the dwarf birch (*Betula nana*, L.) is met with, though only as a bush creeping along the ground, at Cape Schaitanskoj (72° 8′ N.L.); and here in 1875, on the ice-mixed soil of the *tundra*, we gathered ripe cloudberries. Very luxuriant alders (*Alnaster fruticosus*, LEDEB.) occur already at Mesenkin (71° 28′ N.L.), and the Briochov Islands (70° to 71° N.L.) are in several places covered with rich and luxuriant thickets of bushes. But the limit of trees proper is considered to begin first at the great bend which the river makes in 69° 40′ N.L., a little north of Dudino. Here the hills are covered with a sort of wood consisting of half-withered, grey, moss-grown

FIG. 7.—River view on the Yennissi.

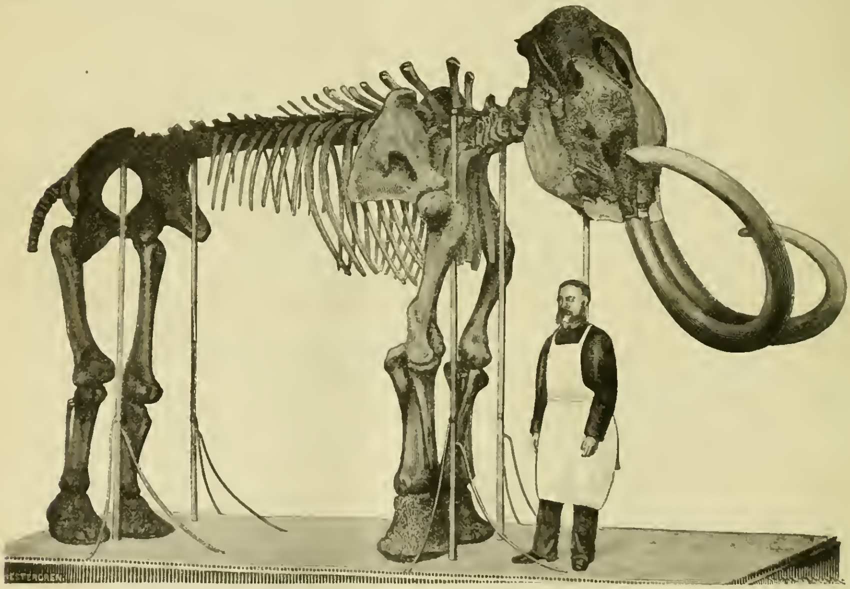


FIG. 8.—Mammoth Skeleton in the Imperial Museum of the Academy of Sciences in St. Petersburg.

larches (*Larix sibirica*), which seldom reach a height of more than seven to ten metres, and which much less deserve the name of trees than the luxuriant alder bushes which grow nearly 2° farther north. But some few miles south of this place, and still far north of the Arctic Circle, the pine forest becomes tall. Here begins a veritable forest, the greatest the earth has to show, extending with little interruption from the Ural to the neighbourhood of the Sea of Ochotsk, and from the fifty-eighth or fifty-ninth degree of latitude to far north of the Arctic Circle, that is to say, about one thousand kilometres from north to south, and perhaps four times as much from east to west. It is a primeval forest of enormous extent, nearly untouched by the axe of the cultivator, but at many places devastated by extensive forest fires.

"On the high eastern bank of the Yenisej the forest begins immediately at the river bank. It consists principally of pines: the cembra pine (*Pinus Cembra*, L.), valued for its seeds, enormous larches, the nearly awl-formed Siberian pine (*Pinus sibirica*, Ledeb.), the fir (*Pinus obovata*, Turcz.), and scattered trees of the common pine (*Pinus sylvestris*, L.). Most of these already north of the Arctic Circle reach a colossal size, but in such a case are often here, far from all forestry, grey and half-dried up with age. Between the trees the ground is so covered with fallen branches and stems, only some of which are fresh, the others converted into a mass of wood-mould held together only by the bark, that there one willingly avoids going forward on an unbroken path. If that must be done, the progress made is small, and there is constant danger of breaking one's bones in the labyrinth of stems. Nearly everywhere the fallen stems are covered, often concealed, by an exceedingly luxuriant bed of mosses, while on the other hand tree-lichens, probably in consequence of the dry inland climate of Siberia, occur sparingly. The pines, therefore, want the shaggy covering common in Sweden, and the bark of the birches which are seen here and there among the pines is distinguished by an uncommon blinding whiteness."

FIG. 9.—Nutti and his wife Aitanga.

After parting with the *Lena* the *Vega* made for the New Siberian Islands, of great interest to science on account of the abundant remains of the extinct mammoth found thereon. "We know by the careful researches of the Academicians Pallas, von Baer, Brandt, von Middendorf, Fr. Schmidt, &c., that the mammoth was a peculiar northern species of elephant with a covering of hair, which, at least during certain seasons of the year, lived under natural conditions closely resembling those which now prevail in middle and even in northern Siberia. The widely extended grassy plains and forests of North Asia were the proper homeland of this animal, and there it must at one time have wandered about in large herds." The mammoth remains the Baron shows are derived from a gigantic animal form, living in former times in nearly all the lands now civilized, and whose carcase is not yet everywhere completely decomposed. Hence the great and intense interest which attaches to all that concerns this wonderful animal (Fig. 8).

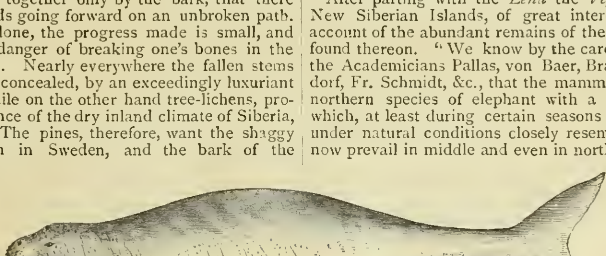


FIG. 10.—Reconstructed form of the sea-cow.

Baron Nordenskiöld then gives an interesting account of all the leading mammoth finds from the earliest period down to the present day. Portions of skeletons of other animal forms have been found in considerable numbers in the New Siberian Islands, and also certain remarkable "wood-hills," highly enigmatical as to their mode of formation.

"These hills are sixty-four metres high, and consist of thick horizontal sandstone beds alternating with strata of fissile bituminous tree stems, heaped on each other to the top of the hill. In the lower part of the hill the tree stems lie horizontally, but in the upper strata they stand upright, though perhaps not rootfast.[1] The flora and fauna of the island group besides are still completely unknown, and the fossils, among them ammonites with exquisite pearly lustre,

[1] Hedenström, *loc. cit.* p. 128. To find stranded driftwood in an upright position is nothing uncommon.

which Hedenström brought home from the rock strata on Kotelnoj Island, hold out inducement to further researches, which ought to yield the geologist valuable information as to the former climate and the former distribution of land and sea on the surface of the globe."

In connection with the state of the ice and the sea here, and the absence of glaciers on the coast, Baron Nordenskiöld gives a classified account of what he deems the various forms of ice. We can only here give a list of the various forms, referring the reader to the book itself for details. We have (1) icebergs, (2) glacier ice-blocks, (3) pieces of ice from the ice-foot; (4) river-ice; (5) bog-ice; (6) sea-ice or heavy ice. After passing Cape Chelgaskoi, on the east of Chaun Bay, on September 6, progress became much slower, and they had become heartily tired of "new ice, shallow water, and fog, and fog, shallow water, and new ice." Here for the first time since leaving Yugor Schar, signs of humanity were seen in the shape of some Chukchi natives who came out to the ship in their boats. A detention of six days at Cape Irkaipi (180° east longitude) afforded an opportunity for examining the games of the race known as Onkilon, who formerly inhabited these regions, and some centuries ago were driven by the Chukchis, according to tradition, to some remote islands in the polar sea. Kolyuchin Bay, just at the north entrance to Behring Strait, was reached on September 28, and just beyond it, and a mile from the shore, the *Vega* was caught in the ice and detained for ten months, till July 18, 1880. It was only after the lapse of some time that the expedition realised that they were caught at last, and serious preparations made for spending the winter. Meteorological and astronomical observatories were erected on shore, and a well-arranged method adopted for carrying out observations of various kinds. To some of the specially scientific results we shall probably refer in separate articles, and particularly to the interesting auroral observations both here and during other expeditions under the guidance of Baron Nordenskjöld. Some accurate notes as to ice-measurements are given in the neighbourhood of the *Vega's* winter quarters, which we give here, as statements on the subject are sometimes so vague.

"When it had become evident that we could make no further advance before next year, Lieut. Brusewitz occasionally measured the thickness of the newly formed ice, with the following results:

THICKNESS OF THE ICE.

1 Dec.	56 centimetres.	1 May,	154 centimetres.
1 Jan.	92 "	15 "	162 "
1 Feb.	108 "	1 June,	154 "
15 "	120 "	15 "	151 "
1 Mar.	123 "	1 July,	104 "
1 April	128 "	15 "	67 " (full of holes).
15 "	139 "	18 "	The ice broke up."

"The exact position of the *Vega* was 67° 4′ 49″ north latitude, and 173° 23′ 2″ west longitude. The dietary and hygienic arrangements were such that no trace of scurvy occurred during the whole winter, and no illness to speak of.

"The greatest cold which was observed during the different months was in

Oct. the 24th—20°·8	March the 29th—39°·8
Nov. the 30th—27°·2	April the 15th—38°·0
Dec. the 23rd—37°·1	May the 3rd—26°·8
Jan. the 25th—45°·7	June the 3rd—14°·3
Feb. the 2nd—43°·8	July the 2nd—1°·0

"Twice we had the barometer uncommonly high, viz.:

On the 22nd December 6 A.M. 782·0 (0°) mm.
On the 17th February 6 A.M. 788·1 (0°) mm.

"The lowest atmospheric pressure, 728·8 (0°) mm., occurred on the 31st December at two o'clock P.M."

The ship was beset in the neighbourhood of a number of Chukchi encampments, and with the natives the most friendly intercourse was kept up during the whole year. Chukchi trading parties from a distance passing on to trade in one of the islands in the strait, made the *Vega* a regular place of call, and thus a great amount of information was gathered from these people of much ethnological value. They have evidently no connection with the Eskimo, whose origin must be sought within the American continent itself. The Chukchis would seem to have been driven up to their present inhospitable abodes a few centuries ago, by commotions in Central Asia; and when the Russians first came into contact with them they were found to be a brave and warlike race whom it was very difficult to subdue. At present they are quiet, harmless, good-natured, and dirty, some having flocks of reindeer and living inland, while the coast Chukchis live largely by fishing. Lieutenant Nordquist learned the language of the people, and was thus able to have important intercourse with them. Large collections were made of their clothing, implements, weapons, utensils, &c., as also of their drawings, for like the Eskimo they have a wonderful capacity for art of a rude and elementary but genuine kind. We give on the preceding page the portraits of a Chukchi and his wife, of such portraits the volume contains many (Fig. 9). Animal lifewas not specially abundant in the land; no bears, an occasional wolf, with a number of foxes, white, red, and black, and hares.

"On our arrival most of the birds had already left these regions, so inhospitable in winter, or were seen high up in the air in collected flocks, flying towards the south entrance of Behring's Straits. Still on the 19th October an endless procession of birds was seen drawing towards this region, but by the 3rd November it was noted, as something uncommon, that a gull settled on the refuse heaps in the neighbourhood of the vessel. It resembled the ivory gull, but had a black head. Perhaps it was the rare *Larus Sabinii*, of which a drawing has been given above. All the birds which passed us came from the north-west, that is, from the north coast of Siberia, the New Siberian Islands or Wrangel Land. Only the mountain owl, a species of raven and the ptarmigan wintered in the region, the last named being occasionally snowed up."

Additional observatories were built during the winter, so that there was a regular collection of them on shore. And so with regular work and amusement, and occasional visits to the Chukchis, the winter passed happily; and on April 23, returning spring brought with it the birds in their migration northward, beginning with the snow-bunting, the "sparrow of the north." The bird and mammal fauna of the Chukch Peninsula and north-east Siberia generally, we may say, Baron Nordenskjöld found to be markedly different from those which prevail in other parts of the Arctic Regions. On July 18, 1880 the *Vega* was as suddenly released from the ice as she was caught, and all at once found herself free to pass through Behring Straits, and thus accomplished the North-east Passage. Space prevents us from following the Expedition in their cruise round the rest of the coast of the Old World. The members of the expedition continued their observations up to the last, and even in Japan, China, Ceylon, and other places were able to add something to our existing knowledge. Considerable time was spent in visiting the north-east coast of Asia, the north-west coast of America, and the islands between. The results are much important information on the natural history and geology of those regions, and a long account of our knowledge of the north coast of Asia from the earliest time including the extensive series of Russian voyages of discovery with which the names of Behring, Steller, and others are associated. Of Steller, Baron Nordenskjöld has the highest opinion, as well as of the value of his work in natural history on Behring Island, and his death

at thirty-seven years of age, through the jealousy and tyranny of Siberian officials was a cruel loss to science. In these chapters, all that is known to science concerning North Siberia and the neighbouring islands has been carefully epitomised, and will form a valuable manual for future scientific work. In cruising from the Asiatic to the American coast, Baron Nordenskjöld makes a remark which has an important bearing on a recent correspondence in these columns. "As in all the Polar Seas," he states, "of the northern hemisphere, so also here, the eastern side of the Straits was ice-bestrewn; the western, on the other hand, clear of ice." We regret that we cannot enter in detail on the many interesting facts given by Baron Nordenskjöld on the natural history of St. Lawrence, Behring, and other islands between Asia and America. He has collected all the information attainable on Steller's sea-cow (*Rhytina Stelleri*), which on Steller's visit to Behring Island in 1741 was found pasturing in large herds on the abundant sea-weed on the shores of the island. Twenty-seven years after, not a specimen was to be found, and it was believed to be then extinct. But Baron Nordenskjöld adduces evidence to prove that a specimen was seen twenty-seven years ago, though there can be little doubt that it has really gone the way of the mammoth. The Baron does not believe that its extinction is due to the destruction by hunters, but that it was a survival from a past age doomed to extinction, which overtook it when driven from its pastures on the shores of Behring Island.

"*Steller's sea-cow* (*Rhytina Stelleri*, Cuvier) in a way took the place of the cloven-footed animals among the marine mammalia. The sea-cow was of a dark-brown colour, sometimes varied with white spots or streaks. The thick leathery skin was covered with hair which grew together so as to form an exterior skin, which was full of vermin and resembled the bark of an old oak. The full grown animal was from twenty-eight to thirty-five English feet in length and weighed about sixty-seven cwt. The head was small in proportion to the large thick body, the neck short, the body diminishing rapidly behind. The short fore-leg terminated abruptly without fingers or nails, but was overgrown with a number of short thickly placed brush-hairs; the hind-leg was replaced by a tail-fin resembling a whale's. The animal wanted teeth, but was instead provided with two masticating plates, one in the gum the other in the under jaw. The udders of the female, which abounded in milk, were placed between the fore-limbs. The flesh and milk resembled those of horned cattle, indeed in Steller's opinion surpassed them. The sea-cows were almost constantly employed in pasturing on the sea-weed which grew luxuriantly on the coast, moving the head and neck while so doing much in the same way as an ox. While they pastured they showed great voracity, and did not allow themselves to be disturbed in the least by the presence of man. One might even touch them without their being frightened or disturbed. They entertained great attachment to each other, and when one was harpooned the others made incredible attempts to rescue it."

Fig. 11.—"Seal-rookery" on St. Paul's Island, one of the Pribilov Islands.

We give a sketch of the sea-cow (Fig. 10), as also of the "rookery" of the sea-bears, still found in abundance on St. Paul's Island (Fig. 11).

But we must take leave of a work abounding in interest, and in every way worthy of the important expedition of which it is the outcome.

NOTES

ONCE more we are glad to chronicle the opinion of a prominent politician on the value of science in education. The unanimity of our public men on this point is gratifying, and is a hopeful change from the ignorance of a few years ago. Sir Stafford Northcote, on Tuesday, in distributing the prizes to the students of Exeter School of Science and Art, maintained that the teaching of science cannot be begun at too early an age, as it is now recognised that a knowledge of science is indispensable in all handicrafts. Whilst acknowledging the great value of central agencies in London, yet he thought it desirable that still greater encouragement should be given to the establishment of museums and to the promotion of scientific research in the provinces. Of course, Sir Stafford stated, the great end attained by science classes was not so much the knowledge of a particular study as the development of the powers of the human mind, and training men to apply the utmost reasoning powers to the everyday work of life. It was the development of this mental vigour that would maintain the supremacy of the English race.

FROM the Report of Kew Gardens for 1880 we learn that the number of visitors during last year was 723,681, being an increase of 154,547 over the previous (very inclement) year, and nearly the same as in 1878. Only a comparatively small proportion of visitors take advantage of the early opening on bank-holidays. The scientific lessons given to the young gardeners have been well attended and successful. The Reports from Indian and Colonial Botanical Gardens are specially favourable this year. "A great increase of activity, arising from a variety of causes, has characterised almost all these institutions with which we are in regular correspondence, entailing a very great extension of the official work transacted at Kew, independent of the purely administrative work of the establishment itself." The numerous experiments described in the Report on various economical plants, both in our Colonial Gardens and at Kew itself, prove the great importance of the work carried on at the establishment to the whole empire. The addition of the Economico-botanical collection from the Indian Museum was a notable event of the year, adding so greatly to the resources of the establishment, and entailing much additional work. Other important additions were the collections of the late Prof. Schimper of Strassburg, and General Munro, C.B. It is to be regretted that Government declined to grant a small retaining fee for an entomologist, whose services are indispensable to such an institution as Kew. Mr. R. McLachlan, F.R.S., has hitherto acted as consulting entomologist without fee.

THE Marchese Corsi-Salviati has presented to the Royal Gardens life-size distemper drawings of the gigantic Aroid discovered by Beccari in West Sumatra, and described by him under the name of *Amorphophallus Titanum*. The dimensions of this plant are probably the most gigantic assumed by any herbaceous plant in one season's growth. The underground tuber is 5 feet in circumference. This produces, except when flowering, a single leaf whose stem is 10 feet high; above, this divides into three branches, each as thick as a man's thigh, and the ultimate segments of the much-divided leaf cover an area of 45 feet in circumference. The inflorescence is on a corresponding scale. The drawings are for the present hung for exhibition in the Wood Museum (No. 3).

THE submarine cable between Dover and Calais was carried out during the month of December, 1851, just thirty years ago, and it was on the 31st that the first message was sent from France to England and the traffic opened to the public. The first message was handed to Louis Napoleon, then Prince-President of the French Republic. It was simply a congratulatory salutation. The second was sent by an English banker to his correspondent in Paris, and related to the price of Consols. The Paris firm sent in return the Côte de la Bourse. This exchange of messages, including conveyance to the several offices, did not take more than an hour. Before regular messages were sent experimental sparks were tried. The first which came over from the French shores fired an English gun which saluted the Duke of Wellington when leaving Dover by an express train. It was the last time he visited the place in his capacity of Lord Warden of the Cinque Ports.

MUCH has recently been written on the labours of medical women in India, and we find that such work is not without its reward also in China. According to the *Celestial Empire*, in the summer of 1879 the wife of Li Hung Chang, the great Viceroy of Chihli, was dangerously ill at Tientsin, and foreign medical assistance was called in. Chinese etiquette forbade the two doctors engaged obtaining sufficient knowledge of the case for treatment, and Miss Howard, an American lady with a medical diploma, was at once called in. Under her care Lady Li soon recovered. The result of this successful treatment of the illustrious Chinese lady was the establishment of a large hospital, under a foreign physician, the funds for which were provided by voluntary contribution from the native literati and gentry. The institution has just been opened by the Viceroy himself. When the news of Miss Howard's success reached America a wealthy gentleman of Baltimore subscribed funds to build a hospital for Chinese women at Tientsin, and the two buildings—one erected by Chinese, the other by American philanthropy—now stand side by side in that town. Li Hung Chang and his lady have both presented commemorative tablets to the hospital. One of them runs thus: "The skilful statesman and the skilful physician are alike in this: that they give their thought to cure what is ill. In the act of administering government and of dispensing cures, what hinders China and other lands from being one family?"

M. LISTON having made a series of very interesting observations on the temperature of water and on the conditions of freezing and thawing of a salted lake, Kupalnoye Ozero, in the province of Orenberg, Dr. Woeikoff contributes to the *Archives des Sciences Physiques et Naturelles* a note, with some remarks of his own on these observations which appeared in the eighth volume of the *Memoirs* of the Russian Geographical Society. This Lake Kupalnoye has a surface of 473 square metres and a depth of 1·42 metres, and its water contains 16 per cent. of salt, its bottom being covered with mud very rich in sulphide of hydrogen. The temperatures of the air having been, during the month of January, 1879, from $-6°·3$ to $-28°·2$ Celsius, with one interruption, when the thermometer reached for one day $0°·2$; the temperature of the water at the surface was from $-3°·4$ to $-13°·0$, and at the bottom, from $-3°·8$ to $-12°·8$. On December 27, with a temperature of air as low as $-21°$, the lake was covered with a viscous ice, which soon began, however, to thaw when the temperature of the air rose to $-6°$, and the temperature of water was as low as $-7°·8$. On January 3 all ice had disappeared, but the temperature of the water was still $7°·2$ below the freezing point. On January 11, the temperature of the air being $-22°$, and that of water being $-9°·8$ at the surface and $-5°·6$ at the bottom, the lake began again to be covered with viscous ice, and soon froze, the ice having a thickness of 38 millimetres, which thickness reached 153 mm. ten days later. But the remainder of the water was still unfrozen, notwithstanding that its temperature regularly decreased to $-10°$ on January 17, and even $-12°·8$ on January 30. It was never observed before, M. Woeikoff says, in laboratories that salt water was cooled below $-4°$, without being frozen, and here we have salt water which remains unfrozen at 13° below zero. However, former experiments, especially those of M. Zöppritz, proved that there is no diffusion of salt before congelation; it seems that in Lake Kupalnoye there is such a diffusion of salt towards the lower strata of water, even before the freezing be-

gins; otherwise it would be difficult to explain how colder water might remain on the surface, were it not for the greater amount of salt in the lower strata. It was always difficult to explain, M. Woeikoff observes, how ice is formed on the surface of oceans, the temperature of the maximum of density being lower than that of the congelation; but the question is complicated in oceans by many causes, and therefore M. Woeikoff asked M. Liston to make observations on a salt lake: but Lake Kupalnoye contains too much salt to be compared with oceanic water, and thus it would be desirable to make experiments on this subject on large tanks filled with salt water, and exposed during the winter in rough climates to the action of low temperatures and of radiation.

In the last number of the Geneva *Archives des Sciences Naturelles*, M. W. Meyer gives an account of the applications of the micro-telephone in the Observatory of Geneva for the transmission of the beats of a clock to observers occupied in different rooms of the Observatory. The experiments have been carried on for eighteen months, and although at first there were many difficulties, satisfactory results have been reached. During last year all comparisons of clocks were made by means of the micro-telephone, with the same accuracy as if they had been made directly. The average error of each observation does not exceed 0·06 of a second, and the constant error, deduced from fifty-nine series of observations, is very small (0·001 of a second). Another very interesting experiment was made in connection with the determination of longitudes between Vienna and Geneva, which was undertaken by MM. Oppolzer and Plantamour. By a new application of the microphone, M. Meyer caused the beats of the Observatory clock to be inscribed automatically on a chronograph; and afterwards, by putting this clock into communication with the Vienna Observatory, he made it inscribe its beats automatically on both chronographs, at Vienna and at Geneva, avoiding thus the auxiliary movement which usually establishes the contact in electrical clocks, and may be a cause of inaccuracy. MM. Plantamour and Oppolzer, being both at the time in Vienna, were able to ascertain the accuracy of this new combination, and they afterwards made use of it for the comparison of the Geneva clock with the electrical chronometer. A few improvements in the microphone add very much to the accuracy of the signals and the ease with which they are transmitted to the chronograph.

On the sensitive surface of the body small spaces (it is known) can be distinguished within which two or more stimuli appear as one or simple; these vary in size and form in different parts. The retina must here be included. Now, the rods and cones forming the mosaic of the retina were recently counted by Herr Salzer, and in the central and most sensitive part—the yellow spot, where are only cones—he found a hundredth of a square millimetre to contain 132 to 138 of these. Dr. Du Bois Reymond has lately tested by experiment the supposition that these elements correspond to the "circles of sensibility" for the retina. If so, the number of light-points which, on the same extent of retinal surface (0·01 sq. mm.) give separate visual impressions, should correspond to Salzer's number of cones. The manner of experiment was this: The observer looked through a tube, blackened interiorly towards a perforated screen which could be shifted in the line of a beam of reflected sunlight coming towards the eye. The screen had, in a frame, a piece of tinfoil 5 ctm. square, perforated regularly with a fine sewing-needle in 460 places. This, while looked at, was gradually withdrawn in the line of sight. A point is reached, at which the light-points tend to unite in short lines; with further removal the lines are continuous, as in a grating; and with still further, the distinction of lines is lost. The distances corresponding to such effects were noted, and again, in bringing the screen back. The results are considered to confirm the view under trial, viz. that the number of circles of sensibility in the yellow spot is equal to the number of cones. When there were seventy-four light-points (or half the number of cones) in 0·01 sq. mm., they could just be distinguished, and beyond 149 the lines disappeared.

In a recent number of *Naturen*, Prof. Axel Blytt concludes the highly interesting series of papers in which he has at some length expounded his theory of the immigrations into Norway of different floras during early dry and wet periods. On carefully examining the oldest Norwegian turf bogs, he finds, as Prof. Steenstrup has shown in Denmark, that four distinct turf layers may be traced between which there are frequently two, or even three, equally distinct deposits, composed of the roots and other remains of trees. The latter are found *in situ*, and by the undisturbed condition of the turf-beds above and below them they afford a conclusive proof that such severed trunks cannot have been cut down by human agency. These separate tree beds the author regards as mementoes of long periods of dryness, which may have endured for thousands of years, and during which the formation of turf was arrested, to be resumed again when a wet period supervened. Such interrupted periods of dryness and wet he considers to be closely related to the several long interrupted glacial periods, which, according to Geikie, have succeeded one another. In accordance with Herr Blytt's view the close of the first glacial age was followed by a dry period in which an Arctic flora appeared in Scandinavia, traces of which, as leaves of *Dryas octopetala* and *Salix reticulata*, have been found in the clay underlying the bogs in Denmark and Southern Sweden, in the latter of which the same flora is to be seen interposed between two ancient moraines. The boreal flora, the author is of opinion, we may refer to a dry period, characterised by great summer heat; and in the deposits belonging to this age we find abundant remains of such deciduous trees as, *e.g.* the hazel and the *Prunus avium*, which are now of rare occurrence in Norway, while many other vegetable forms represented in these beds have been long extinct. The differences observable in the bogs of Denmark and Norway Herr Blytt refers to the fact that while the former has undergone very little if any alteration of elevation, the latter has risen since the glacial age 600 feet above the level of the sea. In Norway the formation of the turf beds may be gauged by their varying elevations. Thus in South-East Norway, where the old sea-level has been raised to a height of 600 feet, the turf is from 20 to 26 feet deep, while at low levels, as 30 feet above the strand, the bogs are seldom more than from 2 to 4 feet deep. The author believes that we are justified in expecting that a more careful working out of the theory of the alternation in early times of dry and wet periods will help to elucidate many hitherto unexplained geological and botanical relations, including the distribution of plants; and he considers it probable that the temperature of the ocean, on which climate so largely depends, may similarly be subjected to periodic changes dependent on cosmical laws not less firmly fixed than those which control the movements of the planetary worlds.

We have received from the editor of the *Natural History Journal* various forms for the entry of observations on meteorology and natural history, which are issued to their correspondents in different parts of the country, the meteorological forms being returned to Mr. J. E. Clark, 20, Bootham, York, while those referring to natural history are communicated to Mr. F. A. Lees, Wetherby, Yorkshire. The proposed meteorological observations are fairly satisfactory as regards the natural phenomena in connection with which they are made. The mean date of flowering of each of the thirty selected wild plants for the last three years is given, a feature in the forms well calculated to awaken and sustain the interest of the observers. By these observations carefully made and recorded from year to year

important data will be collected of no little practical and scientific value.

THE Perthshire Natural History Society has had a most successful bazaar in aid of its Natural History Museum, for which it has now secured in all 3300*l*. As they already have a building, the Society ought soon to be able to show an excellent local museum, and make a fair start in the educational enterprise which they have in view. Did "John Stewart's Wines and Spirits," "B. Smith's Sparkling Burgundy," "Peter McIntyre's Buns and Shortbread," "Donald Laing's 2*s*. Tea of Extraordinary Quality," and such like articles, form part of the exhibits at the bazaar? We would infer as much from the style in which the programme is printed.

THE fifth associated *soirée* of the Literary, Scientific, and Art Societies of Liverpool took place on the 21st inst. at St. George's Hall, under the presidency of the Mayor of Liverpool. Of the societies represented, no less than nineteen have distinctly scientific objects, and number 2700 members. In the objects exhibited in the Great Hall were many of considerable biological and geological interest, especially entomological specimens from the neighbourhood of Liverpool, collected by the Rev. H. H. Higgins, and a set of types of the genus *Nassa*, arranged and named by Mr. F. P. Marrat, of the Free Museum, who has done much to elucidate this group of Mollusca. Numerous lectures were given during the *soirée*; those of scientific interest were—"On the Storage and Transmission of Electric Force," by Mr. Fletcher, H.M. Inspector of Alkali Works; "On the Mersey Tunnel, and its Geological Aspects," by Mr. De Rance, H.M. Geological Survey; "On Life at Great Depths in the Ocean," by Prof. Herdman; "On the Life-History of Shell-Fish," by Dr. Hicks. Prof. Herdman described several new forms of life obtained by the *Challenger*, while Mr. De Rance foretold a probably successful termination to the Mersey Tunnel, now one-quarter completed. Nearly 4000 people attended the *soirée*.

WE are glad to see that a Natural History Society has been established in North London, under the name of the "North Middlesex Natural History Association." A Society of this description was much needed in the neighbourhood, and there is, therefore, every prospect of its doing useful work. The objects of the Association will be the formation of a natural history museum, and a library for reference and circulation among members: also the diffusion of natural history knowledge by means of lectures, papers, discussions, &c. It is also proposed to organise field excursions during the summer months. The meetings are held every Tuesday evening between the hours of eight and eleven o'clock p.m. The Secretary is Charles M. Allen, 26, Ingleby Road, Grove Road, Holloway, N.

THE President of the Royal College of Physicians has appointed Dr. George Johnson, F.R.S., to deliver the Harveian Oration.

THE balloon which was seen in the neighbourhood of Santander in Spain, and which was conjectured to be that in which Mr. Powell was carried off, was probably, according to M. W. de Fonvielle, a French meteorological balloon, sent up by the Paris aëronauts equipped to register the phenomena of the upper atmosphere, and with a polyglot request that it be forwarded by the finder to the address given.

TWO earthquake shocks were felt on the 18th inst. in Switzerland, at Bers, Vevey, Lausanne. A few days previously oscillations were observed in Neuchatel, the Valais, and other parts of Switzerland.

THE long-continued eruption of Mount Vesuvius has within the last few days assumed large proportions. Copious streams of lava have been flowing in an easterly direction. It is noteworthy that this increased activity was preceded by sensible seismic agitation of the soil in the neighbouring provinces.

THE new number of the *Proceedings* of the Bristol Naturalists' Society (vol. iii. part ii., Bristol, Fawn and Son) contains some useful papers. We may mention the following:—On the breathing of aquatic larvæ, by W. J. Fuller; On the preparation of a local flora, by J. Walter White; The boulders of the Bromsgrove district, by Oliver Giles; Catalogue of the Lepidoptera of the Bristol district, by A. E. Hudd; Fungi of the Bristol district, by Cedric Bucknall; A naturalist's rambles in Guernsey, by Adolph Leipner; Recent investigations on the cause of storms, by G. F. Burder; papers on Binaural Audition and the Phenautograph, by Prof. S. P. Thompson; and the flora of the Bristol coal-field, by J. Walter White, Part I. Thalamifloræ.

A REPORT from the German Fisheries Union states that during the season 1880–81 no less than 6,151,036 fish ova were artificially hatched, and with the young brood various German rivers were stocked. Amongst them were 1,792,000 salmon, all from the Rhine (with the exception of 18,000 from Pomerania), 295,000 Californian salmon (imported direct from America), 183,500 sea trout (*Trutta trutta*), 6000 *Trutta lacustris*, 46,000 *Trutta fario*, 270,000 *Salmo salvelinus*, 48,536 American trout, 152,000 *Thymallus vulgaris*, 657,000 *Gymnothorax muræna*, 1,810,000 *Coregonus Wartmanni*, 335,000 eels, 151,000 American eels, and 720,000 carp. The results of the Society's efforts become more and more apparent every day in the largely augmented receipts of German fisheries generally.

ON Wednesday, December 21, diplomas of the Royal Agricultural College, Cirencester, were granted to four candidates, and the sessional certificates and prizes distributed.

ON April 10, 1882, the second International Congress for Ethnographical Sciences will be opened at Geneva. The organisation of the Congress is in the hands of M. G. Becker at Lancy (Geneva), the delegate of the Swiss Ethnographical Institute. All who wish to participate in the Congress must send their names to him or to the delegates of the countries they may reside in. The Congress will be divided into seven sections:—(1) Origin and migrations of peoples; (2) Ethnology; (3) Descriptive ethnography; (4) Theoretical ethnography; (5) Manners and customs; (6) Political ethnography; (7) International law. Delegates have already been announced from the following countries:—France, Belgium, England, Luxemburg, Sweden and Norway, Russia, Germany, Roumania, Greece, Italy, Spain, Portugal, Switzerland, Turkey, Egypt, British India, Japan, Canada, the United States, Peru, Australia, and the Argentine Republic.

THE *Transactions* of the Epping Forest Field Club contain some unusually interesting papers. In parts 4 and 5, for example, vol. ii., we have, among others, the following papers: "Is *Vanessa polychloros* the prototype of *Vanessa urticæ*?" by W. White; "The Evolution of Fruit," by Prof. Boulger; "The Developmental Character of the *Larvæ* of the Noctuæ, as Determining the Position of that Group," by Raphael Meldola; "Infusoria, what are They?" by W. Saville Kent; "Report on the Excavation of the Earthwork known as Ambresbury Banks, Epping Forest, by Gen. Pitt-Rivers." Evidently this young Society is doing good work.

THE additions to the Zoological Society's Gardens during the past week include a Malbrouck Monkey ♀ (*Cercopithecus cynosurus*) from West Africa, presented by Mr. C. A. Rose; a Chilian Teal ♂ (*Querquedula creccoides*) from Chili, presented by M. J. M. Cornely; a Kite (*Milvus ictinus*), European, pre-

sented by Mr. G. H. Tod-Heatley; a Rhesus Monkey ♀ (*Macacus erythræus*) from India, a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, deposited; a White-browed Amazon (*Chrysotis albifrons*) from Honduras, a White-headed Parrot (*Pionus senilis*) from Mexico, a Javan Parrakeet (*Palæornis javanicus*) from Java, two Chestnut-breasted Ducks (*Anas castanea*, ♂ ♀) from Australia, a Germain's Peacock Pheasant ♂ *Polyplectron germaini*) from Cochin China, a Black-throated Diver (*Colymbus arcticus*), two Oyster-catchers (*Hæmatopus ostralegus*) British, a —— Deer ♂ (*Cervus* sp. inc.) from Patagonia, purchased; four Undulated Grass Parrakeets (*Melopsittacus undulatus*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN

THE SATELLITES OF MARS.—The following Greenwich times of elongations of these satellites are taken from an ephemeris contributed by Prof. Pritchett to *Science* of November 26. At elongation *Deimos* is distant about 52″ from the planet's centre and *Phobos* about 21″; the angle of position, 246°. 5h. 13m. are added to the Washington mean time, for difference of longitude and aberration-time:—

Deimos.

	h. m.		h. m.		h. m.
Dec. 30,	11 57 W.	Jan. 2,	15 36 E.	Jan. 4,	13 0 W.
Jan. 1,	9 20 E.	3,	6 44 W.	6,	10 24 E.

Phobos (W. elongations).

	h. m.		h. m.		h. m.
Dec. 30,	8 16	Jan. 2,	12 46	Jan. 5,	9 38
31,	7 13	3,	11 44	6,	8 36
Jan. 1,	6 10	4,	10 41	7,	7 33

COMET 1881 *g* (SWIFT, NOVEMBER 16).—From observations between November 22 and December 12, Herr J. Palisa has calculated the following orbit of the comet: we express the elements in the form usual in the Catalogues:—

Perihelion passage 1881, November 19·9987 Greenwich M.T.

	° ′ ″	
Longitude of perihelion	63 17 57	M. Eq. 1881·0.
,, ascending node	181 21 41	
Inclination	35 11 54	
Log. perihelion distance	0·284788	

Motion—retrograde.

There is still a certain resemblance to the orbit of the first comet of 1792, discovered by Miss Caroline Herschel, as last calculated by Mechain, but the differences in the elements would not be accounted for by perturbation in the interval, so that it is probable the comets are distinct. Maskelyne's observations in 1791-92 will be found in his third volume in a form that will admit of a new reduction.

THE COMETS OF SHORT PERIOD.—No one of the known comets of short period is due at perihelion in the year 1882. The next to return may probably be that discovered by Tempel in July 1873, at the end of the year 1883, and about the same time D'Arrest's comet will be round again. Brorsen's comet follows in the autumn of 1884.

VARIABLE STARS.—The following are Greenwich times of heliocentric minima of Algol, calculated upon similar data to those used for Prof. Winnecke's ephemeris for 1881:—

	h. m.		h. m.		h. m.
January 3,	16 18·9	January 12,	6 45·5	January 29,	11 38·9
6,	13 7·7	23,	18 1·1	February 1,	8 27·8
9,	9 56·6	26,	14 50·0		

Minima of S Cancri occur on January 19, at 13h. 1m., and February 7, at 12h. 16m. A maximum of the "crimson star" R Leporis may be expected about January 19; the period from the last fifteen years' observations is close upon 436½ days.

We may once more draw attention to the star with which Encke's comet was compared by Rümker at Paramatta on June 19, 1822, and which is certainly variable to a considerable extent. Rümker estimated it between the fourth and fifth magnitude; Gould says 6·0 in the *Uranometria Argentina*; the star is 6·5m. in the *Durchmusterung*, but has been several times noted as low as the eighth magnitude: perhaps systematic observation may show that the period is not a long one. The position of this star for 1882·0 is in R.A. 7h. 23m. 21s., N.P.D. 91° 39′·8.

GEOGRAPHICAL NOTES

INFORMATION has been received from Tromsoe which augurs well for the success of Mr. Leigh Smith's present voyage. Capt. Isaaksen, of the Norwegian whaler *Proven*, saw the *Eira* on June 30 at Matushin Straits at the edge of the ice, a few miles from the coast. On July 2 he again saw the *Eira* steaming southward, and he concludes that Mr. Smith failed to force his way along the coast of Nova Zembla. It is supposed that he again failed to pass Kara Straits, as he was afterwards seen bearing north from Gooseland. Capt. Isaaksen says that the ice was in about its usual position in June and July, but on August 8 it had all gone, he did not know where or how. On the 16th of that month there was no ice twenty miles north of Nova Zembla, but a heavy sea was running from the north. This conclusively shows that the sea was open for a very considerable distance, probably as far as Franz Josef's Land, which Capt. Isaaksen feels certain Mr. Smith has reached, and in such circumstances he would not be astonished if tidings came of his having reached a point very much nearer the North Pole this year. As might have been expected, the Russian Government and Mr. Gordon Bennett are doing everything possible to succour the people of the crushed *Jeannette*; we hope they will soon be all safe in Western Europe.

DR. STECKER, the companion of Dr. G. Rohlfs, writes on June 21 to the editor of *Petermann's Mittheilungen*, from Debra Tabor, on the results of his last journey to Lake Tana. He has explored all the lake, visited the mountains on its shores, and prepared a detailed map of this basin, which covers a surface of 2980 square kilometres, the level of which is 1942 metres above the sea, and which is 30 to 72 metres deep. The map will be the more welcome as Dr. Stecker says that all former maps of the Gorgora Mountains, situated north of the lake, and of its southern shores, are quite wrong. Dr. Stecker is satisfied with the reception he received during his journey from the native rulers, and especially from the Negus, who promises to let him go to Kaffa. During his stay at Lake Tana Dr. Stecker made interesting collections of plants, insects, fishes, and molluscs, and he discovered in the Gorgora Mountains unmistakable proofs of volcanic activity: eruptive cones, a crater, and a mighty lava stream, all probably recent, as in the volcanic rocks, he has found inclosed remains of a mollusc which still inhabits the waters of Laka Tana. After the end of the rainy season he proposes to explore the negro tribes who live west of Lake Tana, and then to travel either to the mouth of the Juba River or to Zanzibar *viâ* Lake Samburu, Mounts Kenia and Kilimangaro.

THE expedition led by Lieut. Holm, and sent out early in the summer by the Copenhagen Commission for the geological and geographical investigation of Greenland, has just returned. The expedition proceeded to the southernmost part of Greenland; they succeeded in circumnavigating the large islands on the southern coast, and in determining the exact position of Cape Farewell. The land itself was investigated as far as line drawn from the Tasermint Fjord on the west coast, to the Lindenows Fjord on the east coast. It contains magnificent alpine scenery with enormous glaciers, particularly on the western side. The low-lying eastern part is covered with a layer of ice and snow, which forms hills and valleys, following the soil underneath; here and there mountain peaks rise above the immense winter landscape.

THE *Oesterreichische Monatsschrift für den Orient* for November contains a paper by von Hellwald on the Gilyaks of Eastern Siberia. They inhabit the districts of the Lower Amour, the coast of the Straits of Tartary, and the northern part of Saghalin. Estimates of their numbers vary from 8000 to 3000. Col. Wenjukow thinks they form a special branch of the yellow race, but not a subdivision of the Tungusic stock. Their language, he says, has no resemblance to the Tungusic, and their physiological structure betoken a more powerful and energetic race than the neighbouring Magunes, Samagry, &c. Ravenstein also distinguishes the Gilyak tongue, which is rich in monosyllables, from the Tungusic, and others distinguish it from the Aino, with which it has been sometimes connected. They are said to have oblique eyes, prominent cheek-bones, and scanty beards; the

hair is dark and thick, the nose flat, and the chin pointed. A skull which Barnard Davis succeeded in sending to England was found to have a capacity of 1638 cubic centimetres, with horizontal and vertical indices of 77·3 and 78·3 respectively. They have the reputation of being a bloodthirsty and inhospitable people, but they have now succeeded better than any of the neighbouring tribes in drawing closer to the Russians. They frequently change their paganism for the Russian Orthodox Church. The Japanese, with whom they traded in the southern part of Saghalin, have had no great influence over them. Sometimes they live in houses which are built on piles raised some distance above the ground, with a platform, or balcony around, on which they lay their sledges, nets, &c. From the roof are suspended hundreds of salmon, put there to be smoked and dried. The men pass most of the time away from their families, fishing or hunting. They are especially fond of the dolphin, but as they have but bad weapons of the chase, they rarely succeed in catching this fish. When they do, however, the occasion is kept as a festival. As with most of the aborigines of North-Eastern Asia, they reverence the bear as a divinity, but it is nevertheless almost invariably slaughtered. Their proceedings at the festival of the bear resemble those of the Ainos of Yezo, drunkenness being the order of the day. The religion of the Gilyaks is Shamanism with all its superstitions. They will allow no one to take a spark of fire, even in a tobacco-pipe, from their huts, believing that ill-luck and misfortune will follow. The bodies of the dead are burned, and a small house erected above the ashes, while a favourite hound is slaughtered on the grave. The Gilyaks in Saghalin differ in some respects from those on the mainland. Their mode of living differs little from that of the Ainos. Marriage is not permitted among members of the same family; wives are purchased, but also captured. The Japanese traveller, Mamia Rinso, who thoroughly examined the whole of Saghalin and the neighbouring coast about the beginning of this century, says that polyandry existed amongst them. They are the most superstitious of all the Tungusic tribes in the Amour region, as well as the most cruel in their customs.

THE United States war-steamer *Palos* has been engaged for some time past, by order of the American Government, in carrying out a series of observations in China and Japan with the object of ascertaining the correct latitude and longitude of certain important points. The position of Wladivostock was determined by Russian engineers some years ago, and the object of the present expedition is to settle those of the chief centres between that place and Madras, *e.g.* Nagasaki, Amoy, Shanghai, Hongkong, and Singapore. The positions of the first three have been determined, and it is said do not show any great discrepancy with those hitherto accepted.

THE December number of the Geographical Society's *Proceedings* opens with Mr. F. A. A. Simons' paper on the Sierra Nevada of Santa Marta and its watershed, accompanied by a good map of the region from his own survey. Mr. Delmar Morgan contributes a paper on steppe-routes from Karshi to the Amu-daria, being an annotated rendering of one by M. Maief in the Russian Geographical Society's *Isvestia*. In the Geographical Notes the new Russo-Chinese frontier is described, and there is an interesting note on the old map of Djungaria by the Swede Renat, recently discovered in the library of Linköping. M. Wiener's discovery of the Samiriá tributary of the Upper Marañon is also referred to, and it is stated that he has constructed a map of this almost unknown region. Perhaps the most interesting item in the whole number is the short letter from Capt. Gray, of Peterhead, on the recent advance of the Polar ice in the Greenland and Spitzbergen Sea, with its accompanying ice-chart. A long report on the Venice Congress and Exhibition is furnished by Capt. A. W. Baird, R.E., and is the only one, so far as we know, which has yet been published.

THE last *Bulletin* of the Commercial Geographical Society of Bordeaux contains some notes on M. Ch. Wiener's extensive explorations on the tributaries of the Upper Amazon by a Peruvian, Sr. M. Albornoz, and observations by M. Raeckelboom on the country, &c., between Susa and Kairwan.

DR. LENZ ON THE SAHARA

IN a paper which Dr. Oscar Lenz contributes to the *Zeitschrift* of the Berlin Geographical Society, he gives an authentic account of the results of his journey across the Sahara, from Tanger to Timbuktu, and thence to Senegambia. The real journey was begun at Marrakesh, at the northern foot of the Atlas Mountains, where Dr. Lenz laid in his stores of provisions and changed his name and dress, travelling further under the disguise of a Turkish military surgeon. He crossed the Atlas and the Anti-Atlas in a south-western direction. The Atlas consists, first, of a series of low hills belonging to the Tertiary and Cretaceous formations, then of a wide plateau of red sandstone, probably Triassic, and of the chief range which consists of clay-slates with extensive iron ores. The pass of Bibauan is 1250 metres above the sea-level, and it is surrounded with peaks about 4000 metres high, whilst the Wad Sus Valley at its foot is but 150 metres above the sea. The Anti-Atlas consists of Palæozoic strata. On May 5, 1880, Dr. Lenz reached Tenduf, a small town founded some thirty years ago, and promising to acquire great importance as a station for caravans. The northern part of the Sahara is a plateau 400 metres high, consisting of horizontal Devonian strata which contain numerous fossils. On May 15 Dr. Lenz crossed the moving sand-dunes of Igidi, a wide tract where he observed the interesting phenomenon of musical sand, a sound like that of a trumpet being produced by the friction of the small grains of quartz. But amidst these moving dunes it is not uncommon to find some grazing-places for camels, as well as flocks of gazelles and antelopes. At El Eglab Dr. Lenz found granite and porphyry, and was fortunate enough to have rain. Thence the character of the desert becomes more varied, the route crossing sometimes sandy and sometimes stony tracts or sand-dunes, with several dry river-beds running east and west between them. On May 29 he reached the salt works of Taudeni, and visited the ruins of a very ancient town, where numerous stone implements have been found. Here he crossed a depression of the desert only 145 to 170 metres high, while the remainder of the desert usually reaches as much as 250 to 300 metres above the sea-level; and he remarks that throughout his journey he did not meet with depressions below the sea-level. The schemes for flooding the Sahara are therefore hopeless and misleading. The landscape remained the same until the wide Alfa fields, which extend north of Arauan. This little town is situated amidst sand-dunes devoid of vegetation, owing to the hot southern winds. Four days later Dr. Lenz was in Timbuktu, whence he proceeded west to St. Louis. During his forty-three days' travel through the Sahara Dr. Lenz observed that the temperature was not excessive; it usually was from 34° to 36° Celsius, and only in the Igidi region it reached 45°. The wind blew mostly from north-west, and it was only south of Taudeni that the traveller experienced the hot south winds (*edrash*) of the desert. As to the theory of north-eastern trade-winds being the cause of the formation of the desert, Dr. Lenz remarks that he never observed such a wind, nor did his men; it must be stopped by the hilly tracts of the north. Another important remark of Dr. Lenz is what he makes with respect to the frequent description of the Sahara as a sea-bed. Of course it was under the sea, but during the Devonian, Cretaceous, and Tertiary periods; as to the sand which covers it now, it has nothing to do with the sea: it is the product of destruction of sandstones by atmospheric agencies. Northern Africa was not always a desert, and the causes of its being so now must be sought for, not in geological, but in meteorological influences.

SCIENTIFIC SERIALS

Journal of Anatomy and Physiology, vol. xvi., part 1, October, 1881, contains—Dr. D. J. Cunningham, on the relation of nerve-supply to muscle-homology.—Dr. Gibson, the action of duboisia on the circulation.—J. F. Knott, the cerebral sinuses and their variations.—Dr. G. Barling, primary growth from bone, resembling in some of its features scirrhus carcinoma of the breast.—Doctors George and F. Elizabeth Hoggan, the comparative anatomy of the uterine lymphatics (plates 1 and 2).—Dr. H. Ashby, transposition of the aorta and pulmonary artery in a child of seven months.—Dr. W. Stirling, some points in the histology of the newt, and on the nerves of the lungs of the newt (plates 3 and 4).—Dr. Garson, on pelvimetry (plate 5).—Prof. Turner, cranial characters of the Admiralty Islanders.—Report on physiology, and anatomical notes.

The American Naturalist for November, 1881, contains: W. K. Higley, on the general and microscopical characters of the peach tree affected with the "yellows."—W. H. Dall, on the so-called Chukchi and Namolló people of Eastern Siberia.—W. H. Edwards, the length of life in butterflies.—H. D. Minot notes on the migrations of birds.—V. Havard, on Sotol.—E.

D. Cope and A. S. Packard, jun., on the fauna of Nickajack Cave. Many miles were explored, and no end reached. The invertebrate fauna of the caves proved very considerable, and several new species are described and figured; one of the most interesting is the blind crayfish (*Orconectes hamulatus*, Cope).—Recent Literature, Scientific News, &c.

Rivista Scientifico-Industriale, No 18, October 15.—Malfatti's fossil Italian insects.—On the rectification of the cycloid, by Prof. Dainelli.

Verhandlungen der k.k. geologischen Reichsanstalt, No. 14, September 30.—Inclosures of foreign stones in crystalline limestone, by T. Fuchs.—Picrite-porphyry of Steierdorf, by E. Hussak.—On tentaculites, by O. Novak.—A note on the diluvium of Masenderan in Persia, by E. Tietze.—Travellers' reports.

Journal of the Asiatic Society of Bengal, vol. l. part 2, No. 3, 1881 (October 22).—Geoffrey Nevill, on new or little-known mollusca of the Indo-Malayan fauna (plates 5 to 7).—Dr. O. Feistmantel, a sketch of the history of the fossils of the Indian Gondwána system.—Prof. V. Ball, additional note on the identification of the ancient diamond mines visited by Tavernier.—J. Wood-Mason and Lionel de Nicéville, list of diurnal Lepidoptera inhabiting the Nicobar Islands.

Revue des Sciences Naturelles, tome 1, série 3ᵉ, No. 1, September, 1881, contains:—P. Gazalis de Fondouce, on Tertiary man in Portugal.—Prof. S. Berggren, on the prothallus and on the embryo of Azolla (plate 1).—G. M. Vignier, studies on the formation of tufas of the present epoch.—Dr. P. Amans, anatomical and physiological researches on the larva of *Æschna grandis* (plate 2).—Account of the Zoological Station at Cette.

Revue internationale des Sciences biologiques, October, 1881, contains:—M. Bochefontaine, on the effects of the obstruction of the coronary arteries on the heart's action.—Jules Soury, on the modern doctrine of hylozoism (the doctrine which considers matter as living).—Prof. Hanstein, protoplasm considered as the basis of animal and vegetable life.—Dr. W. Roberts, on the digestive ferments.

THE last number of the *Journal* of the Russian Chemical and Physical Society contains, besides the minutes of proceedings, papers by Prof. Menshutkin, on the etherification of polybasic acids; on the bromides of vinyle, and on cholic acid, by M. Kutcheroff; on the affinities of sulphur with metals, and on the means of discovering cadmium in presence of copper, by M. Orlovsky; and on the potential of hydrostatic pressures, by M. Latchinoff.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 8.—"On the Coefficients of Contraction and Expansion by Heat of the Iodide of Silver AgI; the Iodide of Copper Cu_2I_2; and of five Alloys of these Iodides," by G. F. Rodwell, F.R.A.S., F.C.S., Science Master in Marlborough College.

The experiments herein described are a continuation of those relating to the anomalous expansion by heat of certain iodides, published at intervals during the last five years in the *Proceedings* of the Royal Society. New determinations of the coefficients of iodide of silver are given. Certain physical and chemical properties of cuprous iodide are detailed, and its coefficient of expansion is determined. Five compounds or alloys were prepared, and their physical characteristics examined. They possessed the following composition, and percentage of iodide of silver:—

Composition.	Percentage of Iodide of Silver.
$Cu_2I_2.AgI$	38·2233
$Cu_2I_2.2AgI$	55·3066
$Cu_2I_2.3AgI$	64·9884
$Cu_2I_2.4AgI$	71·2225
$Cu_2I_2.12AgI$	88·1304

They are compared with the five chlorobromiodides of silver previously examined by the author (*Proc.* Roy. Soc. vol. xxv. p. 303), and with the lead-silver iodide alloy last described (*Proc.* Roy. Soc. vol. xxxii. p. 540).

The following are some of the results observed in connection with the new copper-silver iodide alloys:—

"1. The specific gravity varies but slightly, viz. from 5·7302 to 5·6950, and is a little above the mean specific gravity of the constituents."

"2. The melting points are in all cases much lower than that of either iodide of silver or iodide of copper, for while the former is 527° C., and the latter 601° C., the highest melting-point of any one of the alloys is 514° C., and the lowest 493° C.

"3. Some of the alloys possess three points of similar density, and some two, at different temperatures. They are resinous in fracture, and transparent in thin layers. When pulverised they furnish brilliantly yellow powders, unaffected by light.

"4. When heated in a current of carbonic anhydride they volatilise very slowly. Heated in dry oxygen iodine is freely evolved, and oxide of copper appears on ihe surface of the mass. When heated in dry hydrogen hydriodic acid is produced, and the metal is reduced.

"5. The coefficients of expansion of the alloys below the point at which contraction on heating commences, was found to decrease as the percentage of iodide of silver was augmented.

"6. While the iodide of silver commences its considerable contraction at 142° C., the five chlorobromiodides of silver, the percentage of iodide of silver in which varies from 26·1692 to 73·9285, and the lead-silver iodide alloy, the percentage of iodide of silver in which amounts to 33·794, all commenced their contraction at 124° C., that is 18° C. lower, although the coefficients of expansion of the associated bodies necessarily differ. Thus it would appear that 124° C. is the temperature at which iodide of silver commences its passage from the crystalline into the amorphous condition when freed from the attraction of its own molecules, provided no other attraction or influence supervenes; while the attraction exerted when it exists unalloyed with any other substance, and when its molecules are hence much nearer to each other, raises the point at which the change commences to 142° C.

"7. When the same result was looked for in the case of the copper-silver iodide alloys, it was not found. In fact the presence of the iodide of copper, instead of promoting the assimilation of molecular motion and lowering the point at which the change from the crystalline into the plastic condition commences was found to considerably raise it; although the coefficient of expansion of the iodide of copper is lower than that of either chloride or bromide of silver or of the iodide of lead which enter into the composition of the other alloys. Thus:

Percentage of iodide of silver in the copper-silver iodide alloys.	Temperature at which contraction on heating commences.
38·2232	284° C.
55·3066	233°
64·9886	214°
71·2225	199°
88·1304	153°

Hence while 66·206 per cent. of iodide of lead lowered the point of change 18° C., the presence of 61·7767 per cent. of iodide of copper raised it 142° C."

A general discussion of the results is given and the special properties of the alloys described.

Linnean Society, December 15.—G. Busk, F.R.S., in the chair.—Prof. T. S. Cobbold exhibited a large guinea-worm (*Dracunculus*) taken from a pony, and forwarded by Vet. Surg. Frederick Smith from Madras. Only one previous instance of the occurrence of this parasite in the horse has been mentioned, and its authenticity was doubted by Fedschenko and other helminthologists.—Mr. G. S. Boulger brought before the meeting a set of large papier-maché models of insectivorous plants made at Breslau by Herr Brendel under the superintendence of Prof. Cohn. Mr. Boulger explained their adaptation for teaching purposes, and made special referenre by a diagram to the various stages and physiological distinctions of these plants, viz. from simple viscidity of surface to the more complex apparatus in Dionæa and Aldrovanda.—Mr. T. Christy called attention to a volume of the Annual Report of the Commissioner of Agriculture, Washington, U.S. (1879), wherein was embodied much valuable information on the insects and parasites destructive to crops, &c.—Prof. Duncan thereafter gave the gist of a paper on the morphology of the test of the Temnopleuraidæ.—A paper by Dr. Maxwell Masters followed, dealing with a new species of cotton (*Gossypium Kirkii*) from East Tropical Africa. It has an interest historically from being probably the origin of very numerous cultivated varieties. It was obtained by Sir John Kirk growing wild at Dar Salam. Dr. Masters regards it as most nearly allied to *G. barbadense*, which is most

commonly cultivated in tropical Africa; though along the Nile valley *G. herbaceum* is that usually in cultivation. According to authorities, cotton was not cultivated in Egypt in ancient times, and the fact that the varieties now grown there are for the most part forms of *G. herbaceum*, suggests the idea that India is the source whence Egypt has derived the cotton—a notion confirmed by various other considerations. The wild form of *G. herbaceum*, Dr. Masters has previously shown, is probably *G. Stocksii*, Masters, a native of Scinde.—A note on *Abies Pattonii*, Jeffrey, MS. 1851, by Prof. W. R. McNab, was then read. The author mentions that the trees known as *A. Hookeriana* and *A. Pattonii* have been a source of confusion to botanists and horticulturists. Andrew Murray, in 1855, in describing a New North American pine, mixed up the leaf of *A. Pattonii*, Balf., from Mount Baker, with the cone of *A. Hookeriana* from Scots Mountain, Oregon, originally collected by Mr. John Jeffrey. Dr. McNab, in unravelling the error, proposes that as Jeffreys, No. 430, from the Cascade Mountains, named by Balfour *A. Pattonii*, in the Oregon Circular, was unpublished, it should now be referred to *Tsuga Hookeriana*, and the Mount Baker tree he regarded as *T. Pattoniana*.—There followed a paper by Dr. G. E. Dobson, on the digastric muscle, its modifications and functions; and thereafter the eleventh part of the Mollusca of the *Challenger* Expedition, by the Rev. R. Boog Watson, was read in abstract.—Messrs. W. H. Coffin, E. Milner, and S. H. Parkes were balloted for and elected Fellows of the Society.

Mineralogical Society, December 14.—W. H. Hudleston, F.G.S., President, in the chair.—Messrs. H. Baker, F.C.S., and R. Fleming, were elected Members.—The following paper was read:—On some minerals from the sodalite syenite of Julianshaal District, South Greenland, by Johann Lorengen; communicated by Prof. Johnstrup.—Mr. Baring Gould and Mr. Porter Rhodes, who were present as visitors, gave an account of the diamond mine of Kimberley, South Africa, illustrated by photographs of the workings and by numerous specimens, which gave rise to an interesting conversation.

Paris

Academy of Sciences, December 19.—M. Wurtz in the chair.—The following papers were read:—Proofs of the recent formation of the Mediterranean, by M. Blanchard. In the nature and relations of plant species in places more or less apart he seeks evidence regarding changes that have occurred in the configuration of the land. Were the banks of the Mediterranean brought together one might pass from Europe into Africa or into Asia without any trait of nature making one aware of it. Now as very moderate obstacles prevent a dissemination of many plants and animals, the Mediterranean would be absolutely uncrossable by most living species. It is inferred that the sea has been formed in the present age of the earth, when the animals and plants on the coasts were under the same conditions as now. The recent study of the marine fauna, proving that there are few species in the depths, and those present are probably from the Atlantic, is thought confirmative. M. Milne Edwards considered the uniformity of natural productions explained rather by the recent existence of two isthmuses between the northern and southern banks of an older sea, one between Sicily and Tunis, the other between Spain and Morocco. The Mediterranean has probably not been in communication with the Indian Ocean since the Miocene epoch. M. Daubrée also declined, on geological grounds, to accept M. Blanchard's conclusion.—Observations on the decomposition of metallic formiates in presence of water, by M. Berthelot.—On the principle of surfaces of separation, by the same.—M. de Lesseps presented maps and plans of the project of a railway between the Niger and the Soudan, by the Fouta-Djallon. The Fonta-Djallon presents a central plateau 350 km. from the coast and 1000 m. in altitude; five parallel valleys run from it to the coast. The iman of Timbo (in that region) is friendly.—Researches on the fundamental laws of electrodynamics, by M. Le Cordier. This mathematical memoir was deposited as a sealed packet in September.—On a means of preventing the development of phylloxera by turfing the ground in the intervals of the vine-stocks, by M. Bidauld. This proposal is based on the facts that heating of the ground is very favourable to hatching of the apterous, and still more of the winged phylloxera, and that according to MM. Becquerel, bare ground requires in summer a much higher temperature than turfed ground.—Ephemerides of the planet (217) Eudore (continued), by M. Callandreau.—On the introduction of logarithms in criteriums, which determine an upper limit of the number of roots of an equation which are comprised between two given numbers, by M. Laguerre.—On a differential equation of the form $f\left(n\frac{du}{dz}\right) = 0$, by M. Fuchs.—On functions irreducible according to a prime modulus, by M. Pellet.—Theorem of arithmetic, by M. Weil.—Amplitude of diurnal oscillation of the magnetic declination obtained at the Observatory of the Charles Albert Royal College, at Moncalieri, in the years 1879 and 1880, by M. Denza. In agreement with previous data (1871-78) the minimum occurs in the winter months, and the maximum in summer. The values for the summer months are very variable. The mean annual values for the two years are both superior to that for 1878, which, indeed, is the smallest in the period 1870-1881; the minimum seems to have been passed then, or rather between 1877 and 1878.—On the method of M. Lippmann for determination of the ohm, by M. Brillouin.—History of the process employed for direct coppering of cast iron, by M. Weil. He maintains his rights and priority in the invention. His patents date from 1863.—On the diffusion of solids in solids, by M. Colson. When, *e.g.* in a reducing atmosphere, an iron plate is heated in lampblack, not only does carbon pass into the iron, changing it successively into steel and cast iron, but notable quantities of iron are diffused in the carbon. This will occur at a temperature below red. At a low temperature the iron is more easily diffused in the carbon; at a high, the reverse is the case. Nothing of the kind occurs with platinum. For two solids to diffuse into each other, there must be affinity, or more generally, they must react on each other. M. Colson illustrates this, and he describes an experiment establishing the law of the diffusion.—On the temperature of combustion, and on the dissociation of carbonic acid and of aqueous vapour, by MM. Mallard and Le Chatelier.—On chromocyanide of potassium, by M. Moissan.—On the decomposition of metallic formiates in presence of water; production of some crystalline mineral species, by M. Riban.—On a new sub-class of Infusoria, by Mr. Geddes. This relates to curious, small, curved, pear-shaped cells found in the mesoderm of the Planarian *Convoluta*; they have a large central vacuole, and in the wall of this a row of fibrillæ, which, when the cell is in water, are in rapid rhythmic contraction, altering its shape. When in the animal's body, the cell shows but slight contraction. The author thinks these cells parasitic infusoria, and proposes for them the name *Pulsatella convolutæ*; a fourth sub-class, *Pulsatorians*, being here represented.—On a new type of Turbellaria, by M. Silliman. This was got at Roscoff; it is parasitic on a green parasitic nematoid. It is intermediate between Turbellaria and Trematoda, and the author proposes to call it *Syndesmis*. The genital organs are the most remarkable character.—On the live fishes, crabs, and molluscs ejected by the Artesian wells of the Oued Rir (Sahara of the province of Constantine), by M. Rolland. These animals are only for a time under ground in passing from one "bahr" or pond to another.—On the age of the carboniferous limestone of the Central Oural, by M. Grand Eury.—Two posthumous memoirs of M. Delesse were presented: one on the influence of soil on the composition of the ashes of plants, the other on the waters of Savoy.

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THURSDAY, JANUARY 5, 1882

ON THE GEOLOGICAL IMPORTANCE OF THE TIDES

IT has naturally been a source of much satisfaction to me that a man as able and eloquent as the Astronomer-Royal for Ireland should have come forward as an exponent of the theory which I have advanced concerning the part played by tides in the history of the earth and the other planets. I cannot but feel therefore that it may seem ungracious on my part to appear as a critic, and to ask Mr. Ball to reconsider some of the deductions which he has made in his Birmingham lecture (see NATURE, vol. xxv. pp. 79, 103). I refer to the geological aspects of the theory. The interest of the subject will, I feel sure, prove a sufficient excuse for my being thus critical.

There is I believe a growing feeling amongst geologists that the extreme uniformitarian view as to geological action requires modification. We find on the one hand the physicist demanding of the geologist that he should hurry on the rate of action, and on the other hand the geologist telling the physicist to moderate his demands. A theory, therefore, which receives much support from purely astronomical considerations concerning the observed configurations of planets and satellites, and which enables geologists to perceive *how* the rate of geological action may have been more rapid in the past, is valuable as a means of reconciliation between two apparently opposed branches of science. All this has been admirably insisted on by Mr. Ball, but I think that in the revulsion from uniformitarianism he has passed considerably too far into the ranks of the opposite school.

Accepting the truth of the tidal mode of evolution of the earth and moon, the question at issue is as to what portion of the series of changes, since the birth of the moon, falls within the region of geological history.

In my own paper in discussing this point, I said :

"There are other consequences of interest to geologists which flow from the present hypothesis. As we look at the whole series of changes from the remote past, the ellipticity of figure of the earth must have been continually diminishing, and thus the Polar regions must have been ever rising and the equatorial ones falling; but, as the ocean always followed these changes, they might quite well have left no geological traces.

"The tides must have been very much more frequent and larger, and accordingly the rate of oceanic denudation much accelerated.

"The more rapid alternation of day and night would probably lead to more sudden and violent storms, and the increased rotation of the earth would augment the violence of the trade winds, which in their turn would affect oceanic currents. Thus there would result an acceleration of geological action."[1]

At the time when I wrote this I contemplated the possibility of the tides having been, in the earliest geological times,[2] perhaps twice or thrice as high as at present, and I now feel inclined to consider this estimate rather as excessive than deficient. But Mr. Ball speaks of tides of over 600 feet as having perhaps occurred within geological times, and I would now ask him to reconsider the probability of this view.

The older geologists attributed the larger part of denudation to the action of the sea, but according to the modern, and undoubtedly the more correct opinion, the denuding action of air and rain, with the aid of rivers and their countless affluents, is of far greater importance. Mr. Ball does not allude to the probable increase of rainfall, but it would, I conceive, be quite as important as the direct tidal action.

If the ordinarily received theory of the trade and antitrade winds be correct, it follows that in similar planets, at equal distances from the sun and with the same depth of atmosphere, the velocity of the wind should vary as the linear velocity of a point at the planet's equator. The planet Jupiter rotates 2·4 times as fast as the earth, and has a radius $10\frac{1}{2}$ times as great; hence if it were not for the greater distance from the sun the trades should blow with 25 times the violence which we observe on the earth. But solar radiation at Jupiter is about $\frac{1}{27}$ of that at the earth. Hence if Jupiter had an atmosphere of the same depth as that of the earth, the trade-winds might blow with about the same violence. If however there be a much deeper atmosphere on that planet, then the amount of solar heat absorbed might be much greater, and the violence of the winds increased. The bands on Jupiter, which are due to the trades and anti-trades, thus afford some evidence that the atmosphere of Jupiter is very deep. It seems, however, quite possible that the violence of the Jovian trades is due partially, or to a great extent, to the heat of the Jovian nucleus.

But now let us return to the case of the earth. The table of numerical values which I have computed (*Op. cit.* p. 494) shows that, when the lunar distance was ten earth's radii (which gives Mr. Ball's tide of 648 feet), the earth must have been rotating in about seven hours. Accordingly it is probable that the trades and anti-trades blew with about $3\frac{3}{7}$ their present velocity. This violence of the general atmospheric circulation to and from the equator, coupled with the rapid alternations of day and night, would undoubtedly give rise to vortical storms of prodigious violence.

Now if this state of things existed in geological history we should expect to find the earlier sedimentary rocks of much coarser grain than the modern ones; but I am not aware that this is the case. Again to withstand such blasts, the earliest trees should have trunks of enormous thickness, and their leaves must have been very tough, or they would have been torn to shreds. There seems to be no reason to suppose that the trees of the carboniferous period present marked peculiarities in these respects.

It is on these grounds that I venture to dissent from Mr. Ball in the geological interpretation to be placed on the tidal theory, and I think we must put these violent phenomena in pregeological periods.

The dispute is, however, only as to the amount of influence, and I cannot learn that geologists are in a position to affirm that in early periods the storms were not say twice as frequent, and the tides twice as high. The

[1] "Precession of a Viscous Spheroid. &c.," *Phil. Trans.* Part 2, 1879, p. 532. It would occupy too much space to reproduce the other comments on the Geological aspects of the theory.

[2] A double tide would (in round numbers) correspond to a lunar distance of 48 earth's radii, instead of the present 60, and to a day of about 16 hours. A double tide gives a quadruple rate of retardation of the earth's rotation.

acceptation of the view, that they were so, would go far to reconcile the discrepant opinions of the geologists and physicists.

There is, as I learn, some slight geological reason for supposing the tides to have been higher in early times, although this interpretation does not seem to have been hitherto attributed to the fact to which I allude. It appears that in the oldest formations there are beds many feet in thickness covered with ripple marks. The preservation of ripples is due to a fortuitous concurrence of causes, and it therefore cannot be asserted positively that if many ripples are preserved the number of ripples formed was great. Such a deduction possesses, however, a considerable degree of probability, and one of the conditions for the formation of many ripples is a great ebb and flow of the tides.

Lyell's interesting observations on the sands in the Bay of Fundy ("Travels in North America," vol. ii. p. 166), where the tide rises through about seventy feet, seem to show that the preservation of superficial marks on sand occurs principally at neap tides, when large areas of sand are exposed for a long time to the sun, after having been covered with water at the spring tide. Now when the tides were twice as high as at present, there must have been 19 or 20 of our present days in the month instead of 27⅓ as at present, and there would be about 38 neap tides in the year instead of about 26.

Since writing the above I have seen Mr. Hull's paper on this subject in NATURE (vol. xxv. p. 177). The evidence which he adduces is of much interest, and if geologists should generally come to recognise the necessity of a powerful denuding agency in order to explain the earlier geological phenomena, such an opinion will stand in direct confirmation of the theory which I have advanced. Notwithstanding what Mr. Hull says, I am still inclined to adhere more to the moderate views maintained above, rather than to admit the extended application of the tidal theory to geology for which Mr. Ball contends. I conceive that a very great acceleration of geological action would result from tides of even one-hundredth of the height portrayed by Mr. Ball, when such tides are accompanied by an intensification of meteorological action.

If Mr. Hull had read my papers, he would have seen that a necessary concomitant of these changes has been a secular diminution of the ellipticity of the earth's figure. For example, when the tides were 600 feet in height, the ellipticity must have been about twelve times as great as at present. Now Sir William Thomson will not allow that there can have been any great change in the ellipticity of the earth's figure since the consolidation of the earth (Thomson and Tait's "Nat. Phil." § 830).

If this opinion is correct, extended geological action, as resulting from the present series of causes, is absolutely excluded. For myself I am not at present able to see the force of his argument, for various reasons on which it is useless to enter here. But it must be admitted that in any contest between him and me the chances of correctness are enormously on his side.

In conclusion I wish to add that in my first paper I probably attributed too much of the changes in the configuration of the earth and moon to the effect of bodily tidal deformation of the earth's mass. The evidence is strong that such tides are now but small, or even scarcely sensible in amount, and accordingly in all probability the later part of the changes must be attributed almost entirely to the effects of oceanic tidal friction, whilst in the earlier part the tides of the solid or semi-solid matter constituting the planet were the more important. It is remarkable that this view enables us to give a satisfactory account of the inclination of the lunar orbit to the ecliptic, as is shown in a later paper.[1]

G. H. DARWIN

EXNER ON CEREBRAL LOCALISATION

Untersuchungen über die Localisation der Functionen in der Grosshirnrinde des Menschen. Von Prof. Sigmund Exner. (Wien, 1881.)

THIS work is an attempt to determine the functions of different parts of the cerebral hemispheres by an examination of the facts of disease alone, independently of physiological experiment. The difficulties which have to be encountered in the solution of the problem by this method are great, and the sources of fallacy numerous. The facts, collected as they must be from the most diverse sources, are not all of the same value, and errors of observation on the score of inaccuracy or incompleteness have to be taken into account and allowed for. The experiments of disease are as a rule rude, and the conditions highly complex. Certain parts of the brain are more liable to disease than others, and one hemisphere more than the other. Besides the lesion actually discovered after death, there may be others not discovered or not discoverable by our present methods, either coincident merely or indirectly connected with the visible lesion; for morbid anatomy and morbid physiology are by no means coextensive. Exactly symmetrical bilateral lesions are extremely rare in disease, and yet such facts are absolutely necessary for the decision of many important questions.

These and many other circumstances render the determination of the functions of the brain from the data of disease alone extremely uncertain, if not impossible. Until the discovery of new experimental methods a few years ago cerebral pathology, except in one or two particulars, chiefly speculative or purely empirical, was practically in a state of chaos. It is only since the introduction of the new doctrines founded on experimental research that the facts of cerebral disease have begun to be investigated and recorded with any approach to scientific accuracy, and order has begun to show itself where formerly all seemed confusion.

Prof. Exner is of opinion that his predecessors have examined the facts of cerebral disease merely with a view of confirming preconceived theories, and have not exercised sufficient discrimination in the selection of the cases they adduce in favour of the propositions they maintain. In this respect particularly he claims superiority over all who have treated the subject before him.

Out of several thousand cases of cerebral disease on record, he has been able to find only 168 instances of

[1] "On the Secular Changes in the Elements of the Orbit of a Satellite, &c.," (*Phil. Trans.*, part ii., 1880, p. 731).

lesion of the cortex capable of being made the basis of reliable inductions.

He has represented together on a series of figures of different aspects of the cerebral hemispheres the position and extent of the lesion recorded in each case; and he has carefully tabulated the symptoms observed, whether positive or negative. In determining the functions of the parts he follows three methods mutually complementary. First, the method of negative instances;—all the lesions being taken together in which a certain function was not affected. Secondly, the percentage method;—the proportion of cases being indicated in which a certain region was diseased, and the relative frequency of the symptom in question. Thirdly, the method of positive instances, *i.e.* all the cases of disease in which a particular affection was observed;—a method used mainly as an adjunct to the other methods, and not of itself of great force. By these methods he arrives at the determination of certain areas or centres which he terms *absolute*, lesion of which always causes the same symptom. He defines more or less vaguely absolute centres for the upper and lower limbs more especially. In addition to the absolute areas he defines a number of *relative* areas, or centres, for other movements, and different forms of sensibility; the relative areas being those in which lesion does not always, but only *frequently*, cause affection of the function with which they are supposed to be in relation.

The elaborate and carefully prepared figures which accompany the work indicate clearly the areas of latent lesions, as well as the position and extent of the absolute and relative areas which the author describes.

Apart altogether from Prof. Exner's deductions, one thing clearly brought out by the facts is the comparative impotence of the fortuitous experiments of disease as regards the determination with any degree of accuracy of the exact position and limits of any centre whatever. Prof. Exner has a deservedly high reputation as a physiologist, but the manner in which he has handled the facts of disease as set forth in this work is not one on which he can be congratulated.

In his selection of instances he has excluded, without assigning valid reasons, many cases of the utmost importance; and he has included, as instances of localised cortical disease, a large number of cerebral tumours, which by the general consent of pathologists, are excluded, owing to the indirect effect which tumours exert on other parts—effects which can never be estimated with any degree of certainty. In his meagre "sammlung" of 168 instances he has included over thirty cases of tumour, thereby introducing such a large percentage error as to vitiate the whole of his deductions however accurately they may be drawn from his premises. Causal relationship is too readily assumed when none is proved. Mere frequency of occurrence, on which alone he founds his peculiar notion of relative centres, by no means justifies the assumption of causal connection. These so-called relative areas are seen to be capable of destruction without discoverable symptoms, and the same region seems to play many parts, being indifferently a centre for the leg, or the arm, or the face, speech, sight, and so forth. Our author's arguments in favour of his relative centres are in reality not more cogent than would be the inference that because injuries of the foot are frequently associated with disturbance of the circulation, therefore the foot is a relative centre of the circulation, whatever that may mean. If Prof. Exner's localisation of relative centres had any foundation in fact, it would be nothing short of a *reductio ad absurdum* of the whole doctrine of localisation. It is a marvel how a believer in localisation, as Prof. Exner declares himself, can see no incongruity or inconsistency in admitting that the absolute centre for the leg may also be a relative centre of vision. A consistent advocate of localisation might as well admit that the leg may frequently, relatively, or in some way or other be used as an organ of vision.

Among other strange things in this book is the kind of evidence on which our author seeks to establish differences between the hemispheres as to the extent and relation of the sensory and motor centres. In one of his figures of the left hemisphere there is an area in the occipital lobe so coloured as to indicate the position of an absolute centre for the arm, meaning that lesion of this area causes paralysis of the arm in 100 per cent. of the cases. On referring to the evidence we find that the 100 per cent. means only *one* case, a case, moreover, in which there was profound impairment of all the cerebral functions, and extensive lesion elsewhere of the left hemisphere, invading also what is generally recognised as the motor area proper. It is true that in his remarks on this case our author doubts its conclusiveness as regards the arm centre; but inasmuch as his instances give him a case of lesion of the same region in the right hemisphere without any symptoms whatever, he considers it beyond all doubt that this area has a more intimate relation with the upper extremity in the left hemisphere than in the right. It would be difficult to believe that this was written seriously, were it not that a similar style of reasoning is so prevalent throughout the book. Though Prof. Exner advocates the localisation of function in the cerebral hemispheres, the support he gives it is of the most equivocal description.

DAVID FERRIER

THE ROD IN INDIA

The Rod in India. Being Hints how to obtain Sport, with Remarks on the Natural History of Fish, their Culture and Value, and Illustrations of Fish and Tackle. By H. S. Thomas, F.L.S., of the Madras Civil Service. Second Edition. (London: Hamilton, Adams, and Co., 1881.)

THIS is a very much enlarged edition of a very excellent and pleasant book, the first edition of which appeared not quite eight years ago. The author asserts that there is as good fishing, in the angler's sense, of course, of this word, to be had in India as in England; and to prove it we have this goodly royal octavo volume, of over 400 pages and 25 plates. Now, though the fishing is good, it soon becomes apparent that it is something quite peculiar; for though our author himself knew thoroughly well how to "circumvent" a trout in England, and had often done successful battle with the lordly salmon in more northern climes, yet at first he could make nothing of the Mahseer in India, and lost a frightful lot of time in learning the manners and the customs of this Oriental gentleman. The reader of this volume should not cer-

tainly be in such a plight, for he will find in it the minutest instructions for his guidance, and there seems not a *trait* in the character of this and the other freshwater fishes to be ordinarily met with in India that has not been scanned and studied by its author with the intent of beguiling these fishes to their own destruction.

Of the fish to be caught in Indian waters the best is the Mahseer (*Barbus tor*). It is the best from the sportsman's point of view, as it gives him most to do; for who that is a sportsman cares to haul up a dead pike on a night-line? and who that is a sportsman but must care for a fish that can attack as follows?—

"The Mahseer has a greater means than our salmon of putting on steam, and has the habit of always putting it on at once, energetically and unsparingly. His first rush is a mighty one, no doubt; that once made, his strength is, in comparison with the northern fish, comparatively soon exhausted. Other rushes he will make, but his first is the dangerous one; then it is that the final issue of the campaign is practically decided. Be one too many for him then, and you may be grimly satisfied that all else he can do will not avail him; you may count on making him your own. Then it is that you must wait upon him diligently. If you have not got all free, the connection between you and your new friend will be severed within a moment of your making each other's acquaintance. If you should have carelessly allowed the line to have got a turn around the tip of your rod, or have let any slack near the hand become kinked ever so little, or twisted over the butt or hitched in the reel or a button, then it is that not one moment's law is given you for the readjustment of such little matters. There is one violent tug, and an immediate smash:

"'The waters wild go o'er your child,
And you are left lamenting.'

Reader, it takes an eye and a hand, and tact and readiness of mind, as well as a rod and a line and a fly, to catch a salmon; but it takes all these, and something more, to catch a Mahseer."

Although it is well known that a fisherman does not catch his fish for the pleasure of eating them—this being quite a secondary matter—still it is fair towards the Mahseer to mention that when in good condition they are excellent, so rich that one needs no condiment with them, so well flavoured as in this respect to occupy a rank between a salmon and a trout. The best size for flavour is between six and seven pounds; but they are good eating when from two to ten pounds in weight; under the former size they are too bony, over the latter too oily.

The chapter on the natural history of this fish is one of the most interesting in the volume, and it is scarcely necessary to add that there are minute details of how to "circumvent" him, of how to spin for him, and of how to tempt him with a fly, and of how, when, and where to fish for him. When we add that over one quarter of the volume is taken up with this fish, it will be evident at once that he ranks as a lord among the freshwater fishes of India; but we have full details also of the Carnatic Carp (*Barbus carnaticus*), a nearly allied species to the Mahseer, running to twenty-five pounds in weight, taking a fly, having a fancy for a No. 5 or 6 Limerick, and giving good sport.

There are also excellent chapters on many much smaller fishes than these—fishes for light rods, and giving very enjoyable sport; several, like the Black Spot, being dwellers in ponds.

Some information is also given as to the attempts made to stock ponds in India, and there is a very full list given of fishing localities. The lithographs which accompany the volume are very good, and several of them are coloured. To the sportsmen of India this work will be quite indispensable and quite a boon, and further, to all interested in the resources of an Empire presided over by our Queen, the volume will afford an insight into the importance of its freshwater fishes that they will find, we believe, nowhere else.

OUR BOOK SHELF

Book of the Black Bass: comprising its Complete Scientific and Life History; together with a Practical Treatise on Angling and Fly-Fishing, and a Full Description of Tools, Tackle, and Implements. By James A. Henshall, M.D. Illustrated. (Cincinnati: Robert Clarke and Co., 1881.)

THE author in this volume endeavours, and we think succeeds, in giving to the Black Bass its proper place among the freshwater game fishes of North America; and undoubtedly the reader will find himself taking an interest in this fish as he reads this enthusiastic account about it. No doubt the first and second chapters will be most tedious reading, and yet they are full of interest as showing how tangled may become the scientific nomenclature even of a well-known fish. As the sum and substance of these chapters we find the two species of the genus Micropterus, standing, the one as *M. dolomieu*, and the other as *M. salmoides*, and it is of these two respectively—the small-mouthed Black Bass and the large-mouthed Black Bass—that the author writes. Both species are very active, muscular, and voracious, with hard and tough mouths, are very bold in biting, and when hooked exhibit gameness and endurance second to no other fish. Both give off the characteristic musky odour when caught. They generally inhabit the same waters. These Black Bass are wholly unknown in the Old World, except where quite recently introduced. Their original habitat is remarkable for its extent, for with the exception of the New England States and the Atlantic seaboard of the Middle States, it comprises the whole of the United States east of the Rocky Mountains, Ontario, and, last, Mexico. Of late years this distribution has been greatly extended. These fish are very prolific, and rapid growers where food is plentiful. In northern waters six to eight pounds is about the limit of their weight, but in Florida they are sometimes met with up to twelve and fourteen pounds. They have been several times imported into England, and we believe that those brought over in 1879 at the expense of the Marquis of Exeter have succeeded well. The fisherman who reads the latter portion of this volume will find many pleasant anecdotes and stories in connection with the gentle art, and should he happen to frequent those waters where the Black Bass are to be found, he will get many a precious wrinkle which he might have otherwise not known. The author's parting injunction is, "Always kill your fish as soon as taken from the water, and *ever* be satisfied with a moderate creel. By so doing your angling days will be happy and your sleep undisturbed, and you and I and the fish we may catch can say—

"'The lines are fallen to us in pleasant places.'"

An Introduction to Determinants, with numerous Examples. By William Thomson, M.A., B.Sc. (Edinburgh: Jas. Thin, 1882.)

THIS text-book is very accurately described by its title. It belongs to a class of which many examples have appeared on the continent for use in the secondary

schools, and of which the object is to give the more common properties of determinants, illustrate the said properties copiously with examples of the second, third, and fourth orders, and give additional examples of the same kind for practice. The object is here on the whole well attained, there being more examples for the pupil than is usual. For a "beginner's text-book," however, it is unquestionably long-drawn-out and expensive. A book (*e.g.* Dölp's, Bartl's, &c.) with very much more matter and, to say the least, as good in quality, would be got in Germany for two shillings, and this costs five. The object of the author "to render an interesting and beautiful branch of mathematical analysis more accessible to junior students" is thus somewhat frustrated at the outset.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

A Glimpse through the Corridors of Time

THE eloquent and exceedingly interesting lecture by Prof. Ball, F.R.S., under the above title, reported in your journal, has brought to my mind a short, far too much forgotten paper by Immanuel Kant. With your permission I will give a few extracts from this paper, which cannot but be interesting to many of your readers. Kant became subsequently very celebrated in a sphere of human knowledge usually considered far removed from natural science, in consequence of which his papers relating to this science are now almost universally overlooked. Nevertheless some of them contain extraordinary glimpses of truth a century or more in advance of this time, glimpses possible only to genius.

The paper to which I wish more particularly to draw attention was published in 1754, when Kant was thirty years of age. It will be found in the collected works edited by F. U. Schubert and K. Rosenkranz (Leipzig, Leopold Voss, 1839, vol. vi. p. 4). The paper relates to the question whether the length of day has altered, and through what cause. In this paper Kant states: "If the earth were a perfectly solid mass, without any liquid, the attractions of the sun and moon would not alter the rate of rotation round the axis. . . . If, however, the mass of a planet includes a considerable amount of liquid, the united attractions of the sun and moon, by moving this liquid, impress upon the earth a part of the vibrations thus produced. The earth is in this condition." He then goes on to state that the moon produces the greatest effect, and, the tide running round the earth in a direction opposed to that of rotation, "we have here a cause, on which we can count with certainty, incessantly reducing this rotation by as much as it may be capable of." A little further on he says: "When the earth steadily draws nearer and nearer to the end of its rotation, this period of change will be completed when its surface is, relatively to the moon, at rest; *i.e.* when it rotates round its axis in the same time in which the moon revolves round it, and will, consequently, always show the same face to the moon. . . . If the earth were entirely fluid the attraction of the moon would very soon reduce its rotation to this minimum. Herein we at once see a cause why the moon always shows the same face to the earth. . . . From this we may conclude with certainty that when the moon was originally formed, and still fluid, the attraction of the earth must, in the manner above described have reduced the speed of rotation, which then in all probability was greater, to the present measured limit." I have given only a few short abstracts, and I have no doubt that mathematicians may find many faults in the paper, but it is nevertheless clear that Kant had recognised the influence of tidal action, both on the earth and on the moon, and has given a glimpse through the corridors of time a century earlier than any of the authorities mentioned by Prof. Ball.

After Kant it was, I believe, R. T. Mayer, of Heilbron, who, long before Prof. Helmholtz drew attention to the influence exerted by the tidal wave on the rotation of the earth.

Westminster Hospital, December 5, 1881 A. DUPRÉ

Dante and the Southern Cross

I HAD supposed the query—in reply to which I ventured to offer the very brief note which was printed in NATURE (vol. xxv. p. 173)—to have proceeded from some English reader, unacquainted with the various solutions of the difficulty involved in the question, which have been suggested, and who might have been satisfied with a reference to such a discussion of the matter as that in the "Cosmos," by a critic in whom were united all the needful qualifications to a degree which can hardly be looked for elsewhere.

Dr. Wilks appears to have written with a similar impression in referring the querist to the commentary of the late distinguished Dantophilist, Dr. H. C. Barlow, whose fervid belief in the extent of Dante's knowledge ("ottimo Astronomo, summo Teologo") could not be exceeded by the most ardent patriotism, and was never qualified by the judicious reservation which Signor N. Perini admits. What I venture to add, refers to the notes which have appeared, rather than the original query as I understood it.

For a solution of the apparent paradox in Humboldt's retaining the old view of the sense of "prima gente" while accepting —not Galle's "opinion," but—the result of his computations as to the visibility of the stars of the Southern Cross to the earlier inhabitants of Europe, I would refer Signor N. Perini to the earlier and much fuller development of Humboldt's views, contained in the last twenty pages or so of vol. iv. of the *Examen Critique de l'Histoire de la Geographie Moderne*, where, at the same time, will be found a great deal of valuable and suggestive information relative to the Arabian celestial globe theory, and also to the probability (the words "non viste mai . . ." notwithstanding) of Dante having derived some knowledge of the constellations of the southern hemisphere from the description of "Les voyageurs pisans ou vénitiens qui visitaient l'Egypte, l'Arabie et la Perse." But I would at the same time urge that the whole of what is said in the "Kosmos" on the subject of the Southern Cross is not intended to be applied to the Dante question, but to the larger one of the progress of oceanic discovery, and that it was in connection with this larger topic that Humboldt availed himself of Dr. Galle's computations. Dr. Barlow appears to have been misled by failing to notice this distinction in his enthusiastic letter to the *Athenæum* (September 1860) of which the article quoted by Dr. Wilks from the volume of "Contributions to the Study of the Divina Commedia" is a condensation.

Count St. Roberts's essay, to which Signor N. Perini refers, is probably little known, and not easily obtained, in England; but we may conjecture that its object was to argue against the supposition of the element of ecclesiastical mysticism—hateful to modern Italian liberalism—as entering into the Divina Commedia and affecting its imagery and modelling. If the essay had thrown any new light on the subject of the query, we may conclude Signor N. Perini would have imparted it to us. However, I believe that everything that can be found to throw light on this interesting question has been adduced and weighed with the dispassionate calmness of a master mind, as it is set forth with candour and perspicuity in the exhaustive discussions to which I have referred. In conclusion may I remark on the importance, in such correspondence as we have been engaged in, of quoting the original words of an author—with or without translation, as may be thought proper. In the quotation, as from "Cosmos," by Dr. Barlow, given by Dr. Wilks and the passage is re-quoted by Signor Perini—nonsense is made of a sentence by "da" being rendered "since," instead of "whereas." In the same translation "mit vieler Orientalischen Reisenden aus Pisa" is improved into "with many *learned* Oriental travellers of Pisa." Such changes might sensibly affect any argument founded on the passages. For the same reason I would have preferred heading this correspondence "Dante and the quattro stelle." J. J. WALKER

University Hall, December 31

A Pet Baboon

I KNOW not if the inclosed account, written by a friend of mine now resident at Zanzibar, for whose accuracy and truthfulness I can answer, is worthy of a place in your columns.

JULIA WEDGWOOD

"You ask after my quaint little pet baboon, and I really must give you the history of her end. She grew and she grew till

she got to be half as tall as I am, and then, sad to relate, with advancing age her temper did not improve; I am afraid if I spoke the truth I should have to describe it as savage. She became a perfect terror to many people, and she even attacked me once or twice. She was playful to the last when I had her alone, and often resumed many of her old quaint caressing ways that were indescribably fascinating from their childlikeness. But the funny thing was, that if the Bishop was near she would immediately turn upon me and scratch and bite me, and he had only to go out of sight for her good temper to return. At last, however, I felt she was becoming a nuisance to other people, by her habit of grabbing at everybody that passed, and her savage gesticulations; so, seeing also how she longed to exercise those active wiry little limbs of hers—inventing all sorts of ludicrous games and gymnastics—I made up my mind to let her loose. There is a charming little island not far from the shore, which we thought would be just the place Judy would revel in. Mr. —— and Miss ——, and a number of our little boys, escorted her there. She came down to the shore to watch them off, and gave one cry of dismay at being deserted; but we hope that the sweets of liberty have more than consoled her for the loss of society. I missed the creature dreadfully at first. She was a constant amusement and interest with her quaint ways, and even her naughty tempers were ludicrous. Really if Mr. Buckland had been alive I think I should have sent her to him. I think he would have appreciated her intelligence and love of a romp, and she would never have been savage with him. She never once attempted to bite our Bishop; she always preferred him to any one else, and was always affectionate with him. I want very much to know whether other people have noticed that these baboons really laugh; I have heard somewhere, I am sure, that the power of laughter is the distinction between man and animals. But Judy certainly used to laugh—not at a joke I confess; and nothing made her so savage as being laughed at. But when she romped with me she used to open her mouth and show all her white teeth, and regularly laugh like a child, especially when she was tickled. I shouldn't have parted with her if I had been living alone, but living with others, as one does here, it did not seem fair to keep a creature that really did frighten some of the household."

"Tanganyika Shells"

UNDER the above heading a paragraph appeared in NATURE, vol. xxv. p. 101, in which Mr. C. A. White, of Washington, states that certain species described by me in the *Proceedings* of the Zoological Society, 1881, pp. 558-560, from the great African Lake Tanganyika, "are without doubt, generically identical with the *Pyrgulifera humerosa* of Meek," a fossil form from the Bear River Tertiary of North America. Mr. W. H. Dall, of the Smithsonian Institution, had previously, in a letter to me, dated October 24, expressed a similar opinion. I have been unable to procure for examination and comparison a specimen of the North American shell, and am consequently compelled to arrive at a conclusion from a study of Mr. Meek's figure and description in the report upon the "United States Geological Exploration of the Fortieth Parallel," vol. iv., pp. 176-178, woodcut 6, and plate 17, figs. 19-19*a*. As a result I find it decidedly unadvisable at present to locate the two forms in question in the same genus. I admit that in regard to general outline and character of "sculpture" there is no distinction of any importance. However, when the aperture (which in univalve shells most frequently exhibits the main generic characters) is closely scrutinised, features present themselves which incline me, until actual comparison is possible, to hold these two types generically distinct. The outer lip of *Pyrgulifera* is said to be "subsinuous at the termination of the shoulder of the body volution above," and the basal margin of the aperture is described as "faintly sinuous." On the contrary, in *Paramelania* no trace of the latter character is present, and the upper extremity of the labrum where it joins the volution, instead of being "*subsinuous*," is actually *prominent*. But another equally important distinction is the prolongation of the body-whorl below the aperture, together forming a more or less basal effusion. Independent of these actual differences, we must take into consideration certain probabilities and improbabilities. In the first place the difference in geographical position militates to some extent against the identity of these two forms. Then the vast lapse of ages surely must have evolved some differences in the animals as indicated by the dissimilar apertures, and again the operculum of *Paramelania* is very peculiar, and who shall say that this appendage was of a like nature in the Bear River shell. In conclusion, I should observe that the African form was considered of sub-generic rank by me, and not as a distinct genus, as stated by Mr. White.

EDGAR A. SMITH

The Growth of Trees

JUST fifty years ago I was at school in Salisbury. I have only visited it once since until last week, when I had the unique pleasure of rambling over the old but familiar haunts, of course including Old Sarum. On mounting the outer ring of the well-known mound from the Stratford side, a beech tree in the bottom of the ditch reminded me that it was just there our usher carved with his knife on such a tree "Tempus Fugit." On going down to look for the motto, I only found unreadable abrasions on the bark, but on the north side of the same tree "1817" was distinctly engraved. On examining a tree near, I found on the bark "Carpe Diem, 1831." This recalled to my memory the fact that our usher's "Tempus Fugit" was suggested by some such motto carved by the usher of another school. Is it worth recording that this carving on the bark of a beech tree is quite legible after an interval of fifty years, while the date "1817" on another is also probably genuine? If so, perhaps it is worth noticing that both legible carvings are on a north aspect not reached by the sun, while the lost motto "Tempus Fugit" would be exposed to the sun with an easterly aspect.

Barnstaple, January 2 W. SYMONS

INDIAN FOSSILS.—Mr. Richard Lydekker, of the Geological Survey of India, asks if any of our readers can give him information as to the whereabouts in England of collections of fossil bones from the Siwaliks of India. He is aware (beside the British Museum collection) of collections at Ludlow, Cambridge, and Edinburgh, but he believes there are others in the country. A large collection was sent home some years ago by a Major Hay, the destination of which is unknown to him. Mr. Lydekker is now engaged in working at Siwalik fossils, and as he intends spending some months in England next summer, he wishes to look up all the collections then.

OUR ASTRONOMICAL COLUMN

COMET 1881 *b*.—Notwithstanding some statements to the contrary, the orbit of this comet when the later observations are brought to bear upon it, is sensibly different from a parabola, and from two independent investigations, the first by MM. Dunér and Engström, the second by M. Bossert (from eight normal places, based upon 423 observations), the period results about 2955 years. An observation at Marseilles on October 24 gave at 9h. 39m. 4s. mean time, R.A. 18h. 44m. 58·12s., N.P.D. 20° 24′ 23″·2, corrected for parallax.

The following positions are given by Dr. Dunér:—

At 12h. Berlin M.T.

		R.A. h. m. s.		Decl. N. ° ′		Distance from Earth.
January 10	...	22 58 11	...	57 28·3	...	3·118
12	...	23 3 4	...	57 15·5		
14	...	— 7 53	...	57 3·3	...	3·195
16	...	— 12 39	...	56 51·5		
18	...	— 17 22	...	56 40·3	...	3·274
20	...	— 22 1	...	56 29·5		
22	...	23 26 38	...	56 19·2	...	3·354

The student of this branch of astronomy will be aware that comets have been followed to greater distances; the extraordinary comet of 1729, which never approached the earth, indeed could not approach her, within three times the earth's mean distance from the sun, and yet was visible with small telescopes, still affords a unique case, it must have been a body of an altogether exceptional character.

THE MINOR PLANETS IN 1882.—The supplement to the *Berliner Astronomisches Jahrbuch* for 1883, containing ephemerides of the small planets for 1882 has been circulated in advance of the publication of the volume as usual for some years past. Of the two hundred and twenty members of the group detected up to the present time, we find approximate places for every twentieth day of 217, and accurate opposition ephemerides of 41. The approximate ephemerides include No. 220. Three only of the planets approach the earth at opposition, within the earth's mean distance from the sun, viz. No. 12, *Victoria*, in

August, distance 0·891; No. 80, *Sappho*, in September, distance 0·847; and No. 27, *Euterpe*, in December, distance 0·980. No. 157, *Dejanira*, comes into opposition and aphelion about the same time, and the magnitude descends to 15·7. The last of the minors discovered is in opposition in December, mag. 14·6, but No. 216, also a recent discovery, is as bright as 8·4 at opposition on October 7. There is perhaps not much hope of recovering *Medusa* (which from the best orbit obtainable from the short course of observation in 1879 would appear to have the least mean distance amongst the small planets) in the present year, the magnitude being only 13·5, and the computed places necessarily liable to considerable error. Nos. 205, 207, 208, 210, 212, 216, 218, 219, and 220 are still without names.

MR. W. R. BIRT.—Mr. Birt, so well known in connection with lunar work, died at Leytonstone on December 14 in his seventy-eighth year. He had occupied himself some fifty years since with the variable stars, and announced in 1831 the variability of α Cassiopeiæ, a difficult case, for the fluctuation in its light would appear not to exceed a half-magnitude, and indeed has been doubted by no less an authority than Prof. Julius Schmidt. Sir John Herschel, however, supported Mr. Birt's conclusion, and we were once shown by the late Prof. Heis a series of curves exhibiting the results of several years' observations, which indicated sensible though very irregular variability. Much of Mr. Birt's lunar work was undertaken under the auspices of a Committee of the British Association, and his maps of various parts of the moon's surface, extending to great detail, are well known.

M. ALFRED GAUTIER.—In the death of M. Alfred Gautier, at Geneva, on November 30, at the age of eighty-eight years, as already announced, the Royal Astronomical Society have lost the oldest Associate upon their list; he died in full possession of his faculties after a very short illness. M. Gautier was elected into the above Society in January, 1822, or two years after its formation. M. Plantamour of Geneva now heads the list of Associates.

THE SMOKE ABATEMENT EXHIBITION

THIS Exhibition originated, as explained in the introduction to the Catalogue, in the action of the Committee of the National Health Society, with whom the Kyrle Society afterwards joined in appointing a Joint Committee to consider how action could be taken which should tend to the abatement of the smoke produced in the metropolis. In the words of this introduction, "The first proceeding of the Committee was to communicate with colliery owners and manufacturers of heating apparatus as to the means available for the reduction of smoke, and next with the metropolitan parochial authorities and public bodies, directing their attention to the serious and increasing evil, and asking their co-operation in abating it." Public meetings were held at the Mansion House and other places in different parts of London; and the public interest in the subject appearing to be sufficient to justify such an experiment, the Committee determined to hold an exhibition of appliances for the reduction of smoke both in manufacturing and domestic fires.

The idea entertained by the promoters of the Exhibition has been that, in order to effect a reduction in the quantity of smoke poured out of chimneys of different kinds in large towns, it was first necessary to convince people that appliances exist which will tend to this result, and it was therefore determined to invite an exhibition of smokeless fuels, and apparatus for burning them, as well as of appliances for lessening the amount of smoke given off by bituminous coal. The call has been very readily responded to, and the catalogue shows a list of over 230 exhibitors.

Tests are being made by experts of the performances of the different apparatus, which, in the case of the domestic grates, &c., are carried out in specially constructed rooms; the fumes passing up the chimneys being carefully examined to determine the quantities of carbon (other than carbonic acid) and other unconsumed matter passing away from the fire; the consumption of fuel and the temperatures maintained being also carefully noted. A jury has been appointed to award prizes, medals, &c. to those appliances which they consider best adapted to fulfil the purposes in view.

The Exhibition is naturally divided into two great divisions: appliances for trade purposes, and those for domestic purposes. In the first division the economic use of gas instead of solid fuel is illustrated in a small kiln for burning pottery and glass, and its use, instead of steam, is shown in several different kinds of gas-engines. The means of producing steam, however, occupies the principal place in this division. Several mechanical stokers and other appliances for firing boilers, so as to produce no visible smoke, are shown, and those which are at work demonstrate that—at least after steam has once been got up—it is easy to raise any quantity of steam without the production of smoke at the top of the chimney. Moreover, as these appliances are stated, on apparently good authority, to effect an economy in the expense of raising steam, it is to be hoped that their adoption is rapidly becoming general.

It is with the second division, however, that most individuals are more particularly interested, and it is from fires of this kind that the bulk of the smoke is produced, at all events in the west end of London.

Domestic fires, again, may be divided into two classes, those for cooking and those for warming rooms. It is with the latter that we propose to deal in this article. And first we will consider what it is that we want in our living rooms. We are strongly of the same opinion as Sir F. Bramwell, that we must have an "open, pokeable, companionable fire."

We believe that the value of an open fire for warming living rooms cannot be too strongly insisted on; Dr. C. W. Siemens has lately pointed out why a room in which the air is comparatively cool, and the walls, furniture, &c., are warmed by rays from the fire, as is the case when an open fire is used, is so much more pleasant and healthy than one in which the air is warmed by contact with hot surfaces of the stove or heating apparatus, and the walls, furniture, &c., are at a lower temperature, and we believe it is to the use of open fireplaces that the general freshness of complexion of the inhabitants of these islands, and the absence of the use of spectacles among the young, are in a very large measure to be attributed.

One disadvantage in open fires, which has been much dwelt upon—the waste of fuel—is we believe considerably exaggerated. Doubtless a small proportion of the coal used in an open fire-place would be sufficient to maintain the temperature of a room if a close stove were used. But is the rest so entirely wasted as some would have us believe? The greater part of the heat, as they say, "goes up the chimney." Is it therefore wasted? We think not. It performs work in ventilating the room, and it is at least doubtful whether in an ordinary dwelling room the same quantity of vitiated air could be removed (and therefore the same quantity of fresh air be introduced) as cheaply and conveniently by any other means; at all events, the so-called "waste heat" could not be made use of to any large extent as radiant heat, and open grates are shown in the exhibition in which a part is utilised in warming air for admission to the room, or heating water-pipes, &c.

The problem of how to have an open fire without smoke, or with considerably less smoke than we have at present, is one towards the solution of which we hope this exhibition will give valuable assistance. Fires are shown in which gas, coke, these two together, anthracite, or Welsh coal, and bituminous coal, respectively are the fuel. Several different kinds, both of gas stoves and open gas fires are shown. There seems to be no novelty in any of them, and we believe that they are generally so well known as to need no description here; they have the merit of being extremely handy and cleanly; they are not

"pokeable" nor very "companionable," and we are afraid that the very unpleasant fumes of burnt gas—caused, we suppose, by so many of the gas fires shown not being provided with flues—which pervade this portion of the exhibition when the gas apparatus is shown, must prejudice visitors very much against the use of these very valuable appliances.

Dr. Siemens' coke and gas fire, which has been so recently described in these columns, is shown by several exhibitors. It is necessarily free from visible smoke, and almost so from dirt and dust, and it is very manageable; that is to say, by altering the supply of gas the heat may be easily and quickly regulated. How far it is free from the noxious fumes which usually seem to accompany the combustion of coke or smokeless coal in a room cannot be judged in the exhibition.

The same remark applies to the many grates shown for burning anthracite and smokeless coal. Many of these look very nice; a bright, hot fire is obtained which almost comes up to Sir F. Bramwell's standard. It seems to us, however, that anthracite fires are not very manageable; the fire must burn at one rate, and the fuel must be supplied accordingly; you cannot quickly get up a hotter fire by the use of a poker, as is so easy with bituminous coal, nor can you so easily reduce the fierceness of the fire as can be done with so many grates in which bituminous coal is burnt. The absence of smoke is, however, a very great advantage, and unless this can be attained, or nearly so, with bituminous coal, we ought to be prepared to give up the luxury of its use.

There are two methods by which it appears possible to reduce very considerably, if not to prevent entirely, the production of smoke in domestic grates. One is to supply the coal to the fire in such a way that the smoke and gases escaping from the portion last supplied may pass through the live coals and so be consumed; the other is to introduce a draught of hot air at the top of the fire, there to meet and consume the smoke and gases given off by the newly-supplied coal.

Dr. Arnott's stove is a type of the first method. In it the coal for the day's use is put into a box underneath the grate, which latter has no bottom; by means of a lever the bottom of the box is raised, and fresh coal pushed into the fire as required. There is thus no escape for the gases given off by the fresh coal but through the hot part of the fire. These stoves, however, have never come into very common use. We believe that they are not found to be pleasant in a room, and that the reason of this is that although little or no smoke is given off, there is not sufficient air admitted to the fire to burn the carbonic oxide produced, the grate being closed at the bottom, sides, and back, and the front being narrow. No stove of exactly this description is shown in the exhibition, though there are several in which the principle for getting rid of the smoke is adopted. Messrs. Brown and Green, of Luton, Bedfordshire, show a register stove for bituminous coal (and a kitchen range on the same principle), in which the coal is supplied to the fire by a kind of trough or shallow hopper placed in front of the bottom bars, from which the coal can be pushed into the fire, to facilitate which operation the bottom of the grate is made to slope upwards towards the back. Mr. Engert places a box for the fuel at the back of the grate. This box has a sliding back worked by a screw underneath, by which means the fuel is pushed forward into the fire as required. He thus secures a wide front for his fire, and less depth of live coal than in Dr. Arnott's stove. By means of a kind of baffle plate hung at the back of the grate the gases issuing from the coal-box are deflected into the fire instead of going up the chimney. The coal-box can be recharged if necessary without actually putting out the fire. It appears possible to adopt this arrangement to an existing grate of ordinary form at comparatively small expense.

Messrs. Martin and Co. seek to attain the same object by having movable cheeks to the grate, which work horizontally inwards by levers. The coal being put on at the sides is gradually pushed in by this means towards the more active part of the fire. The back plate of the grate has a space behind, and is perforated in the centre so that heated air is thus admitted at the centre of the back of the fire to assist in the combustion.

Thompson's patent consists in having the front of the grate made so as to slide upwards a few inches. The bottom of the grate consists of a plate of iron and is fixed. For the purpose of putting on fresh coals a tool is used consisting of a sheet of iron of the same shape and size as the bottom of the grate, hinged to a rod somewhat like an ordinary poker at a distance from its end equal to the height from the hearthstone to which the front of the grate rises. The iron plate being pushed in between the coals and the bottom of the grate with the rod in an inclined position, the handle of the latter is pushed forwards, the whole body of the fire and the front bars are thus lifted a few inches, and the fresh coal is put in between the two plates; the implement being withdrawn, the front of the grate falls again to its proper place, and the live coals come in immediate contact with the fresh coal underneath it. The back of the grate is perforated, so as to admit heated air to the fire. This arrangement could probably be adapted to many existing grates, without very great expense.

Saxon Snell's patent consists of a cylindrical grate mounted on a very strong horizontal pivot at the back, and in the line of its axis. At opposite sides of the perpihery are two grated doors which are hinged to the back edge of the grate; the uppermost one is opened, and lies back against the chimney-back. When fresh coal has been put on, the upper door is shut and fastened, and the grate turned half round, so as to bring the other door to the top, and the live coal above the fresh coal. We believe that the combustion in this grate would be improved by some holes in the back through which heated air might be admitted near the top of the fire, and these could easily be made.

The grate shown by E. R. Hollands, of Newington Green, is rather more complicated than some of those which we have described; but its performance appears to be good. A movable set of bars fit in between the fixed bottom bars of the grate; and the lower part of the front is made to open forwards and downwards. A neatly-devised motion worked by a lever at the side of the fire-place raises the movable bottom bars, and with them the fire, and opens the lower part of the front, the fresh coal being then placed between the two sets of bars, the return of the lever to its place causes the front of the grate to shut and the movable bottom bars first to recede through the back, and then, having fallen below the level of the fixed bars, to come forward and up again into their original place. The back of this grate is hollow and is pierced with small holes at about the level of the top of the fire. The combustion effected by the hot air passing through these holes is clearly visible.

In the slow combustion grate of Fredk. Edwards and Son, which is shown in action, the "Arnott" principle is made use of, but instead of the bottom being movable, a counterbalanced shutter works vertically in front of the grate, which is very deep. The latter being filled and the fire lighted from the top, the shutter is adjusted from time to time, so as to obtain the requisite amount of fire, by exposing more or less of the front of the grate.

Messrs. Musgrave and Co., of Belfast, besides several of their well-known "slow-combustion" stoves, show a fire-place which they call the "Ulster." In this the coal is fed into the back of the fire from a hopper placed behind the chimney-back, in which is a close-fitting door for closing the opening through which the hopper is filled. The coal is pushed forward into the fire by an arrange-

ment worked by a lever at the side of the grate. The coal is thus coked before it comes into the fire, the only escape for the gases being through the glowing coals. Somewhat similar in some respects to this is the "Wonderful" grate of Archibald Smith and Stevens. In this the fireplace is closed by an iron plate, in which are three rectangular openings one above the other. To the lowest, which is about the floor-level, the grate is fitted; this, made of a basket shape, can be mounted on a pivot in the plane of the plate, so that more or less of the grate may project into the room. Between the top hole in the plate and the upper half of the bottom hole is a flat-sided tube, which curves backwards into the fireplace. This is the hopper for the fuel; it is shut at the top by a close-fitting door, and the curved shape causes the fuel to descend easily into the fire. The centre opening of the plate is provided with a register door, and in some instances is covered with a hood. The arrangement of the hopper causes the gases evolved by the fresh coal to pass through more or less of the live coal before they can escape, and by closing the centre opening the whole draught is made to go down through the lower half of the bottom opening, causing a rapid combustion. Four of these grates are shown in action, with different sorts of fuel. They seem to require little or no attention for hours together, as the feeding arrangement appears to act well.

A grate of the pattern which has been in use in barracks for the last two or three and twenty years is exhibited. This grate was devised by Capt. Douglas Galton. It consists of a cast-iron stove, entirely open in front, which is fitted to the chimney opening, leaving a considerable space between the stove and the brickwork at the back. Into this space air is admitted from the outside of the building. From the top of the fireplace recess proceed two flues; one, the ordinary chimney-flue, receives the covered smoke pipe from the stove, the other delivers into the room through a lowered opening a little below the ceiling level, the air which has been warmed in the chamber behind the stove, the back of which has iron plates projecting from it, so as to increase the heating surface. The cast-iron stove is entirely lined with fire-brick, in the manner to be described, so that the air does not get unduly heated.

A little above the level of the fire the stove is gathered in towards the room so as to form a kind of baffle. The actual grate is formed as follows:—two fire lumps are placed on the hearthstone with a space between them of six inches or so, over which is a cast iron grid; the cheeks and back, all of fire-brick, rest on these first lumps; another lump of fire-brick of curved section underneath fits on the top of the back and cheeks, and underneath the gathered in part of the stove. Between the back fire-lump and the iron back is a space, and there is also a small opening between the back piece and the top piece, through which air heated at the back plays on the top of the fire and helps to consume the smoke. This stove is, we understand, found to be very economical in action, and is very highly spoken of in the work of the late General Morin on Heating and Ventilating. It will not, however, be tested in this Exhibition, as it is not shown in competition.

Messrs. Barnard and Bishop, of Norwich, have pushed the "baffle" principle still farther in their "glow" stove. Instead of coming only about half over the fire as in the Galton grate, the baffle consists of a fire-brick which projects nearly to the plane of the front bars of the grate, and slopes down slightly towards the front. The bottom of the grate, which slopes upwards, and the back which slopes backwards, are made of fire-brick in one piece, the front bars being the only ironwork about the grate. A flue which goes up behind the back opens to the fire just under the back edge of the baffle, the space under which and over the fire is thus converted into a combustion chamber in which the gases from the coals are burnt, and as these have to pass over the front of the baffle before going up the chimney the radiant heat from them comes into the room.

Several grates are shown by different makers, in which the combustion of the gases is accomplished with a down draught. But in these cases the radiant heat evolved in the process cannot come into the room directly, as it does in the case of the "glow," it is therefore lost in the case of a grate set in a fireplace unless it be utilised to heat air which is admitted to the room. A small open-fronted stove on this principle is shown by Mr. T. E. Parker, in which the combustion appears to be very perfect. The internal arrangement is too complicated to describe without a drawing, but the essential point is that the draught from the fire is led away at the back of the bottom of the grate into a flue lined with fire-brick, where it meets a draught of fresh air which has been warmed by contact with the underside of a ribbed plate which forms the bottom of the grate.

Several examples of grates with down draught and chambers for heating air to be admitted to the room are to be found in the exhibition, as well as some in which the heating chamber or flues are applied to grates with ordinary up-draught. The warm air inlets are usually placed close to the fire, which is, in our opinion, a mistake, as the general circulation of air in the room is not so much promoted by this arrangement as when the inlets are at some distance from the fire; there are, however, difficulties in so placing them in an ordinary living-room.

A stove of a peculiar, and we believe quite novel, construction is shown by Mr. James B. Petter. The recess of the fireplace is lined with white marble; in each jamb is a circular hole from which a pipe leads round to the chimney. The fire-box is mounted on legs with castors, so that it can easily be rolled in or out of the fireplace, and is provided with horizontal exit flue pipes at the sides which are connected with the openings in the jambs by sliding pieces. A vertical section of the fire-box from front to back is of open spiral or Nautilus form. The box is made of iron and lined with fire-brick from the lip to the top of the back, there being no bars either in the front or bottom. The coal is put on thinly at the lip, and gradually pushed back, as in stoking a steam-boiler. A rather sharp draught is produced over the red hot fuel towards the back, and the convolution of the box appears to form a kind of combustion chamber. It would seem that the difficulty of lighting the fire would be considerable, but it appears to work well.

We have endeavoured in this notice to give a slight sketch of such grates, &c., as present any salient features. We may have overlooked some which were deserving of notice, but we would earnestly recommend our readers to pay a visit to this very interesting exhibition, and to form their own opinion of the merits of the various apparatus shown.

We may mention that representatives have been accredited to the Exhibition by the Governments of Austria-Hungary, France, Prussia, Saxony, and the United States; and that the interest taken in it has encouraged the Committee to entertain the idea of holding an International Exhibition in about three years' time of such further developments of smoke-abating appliances as may be produced either in this or other countries during the interval.

THE CHEMISTRY OF THE PLANTÉ AND FAURE ACCUMULATORS

PART I.—*Local Action*

AMONG the important discoveries of late years, few have claimed so much attention, or have been so full of promise for practical use, as the accumulator of

Planté and its modifications. Our attention was very naturally directed to the chemical changes that take place in these batteries, especially as it appeared to us that there must be certain analogies between them and some actions which we had previously investigated. In the present communication we propose to treat merely of one point—that of local action, leaving the fuller discussion of the subject to some future occasion.

It is well known that metallic zinc will not decompose water even at 100° C., but we found that zinc, on which copper had been deposited in a spongy condition, was capable of splitting up the molecule even at the ordinary temperature, oxide of zinc being formed and hydrogen liberated. If placed in dilute sulphuric acid, it started a very violent chemical action, sulphate of zinc and hydrogen gas being the result. We termed the two metals thus conjoined, the *copper-zinc couple*, and this agent was fruitful in our hands in bringing about other chemical changes which neither metal singly would effect. Electricians will readily understand the nature of this agent, and will recognise in its effects only a magnified form of what we are all familiar with under the name of *local action*. Now the negative plate of a Planté secondary battery is a sheet of lead, upon which finely-divided peroxide of lead is distributed. It is well known that the electromotive force of lead and lead peroxide in dilute sulphuric acid is nearly three times that of zinc and copper in the same liquid. We were therefore induced to think that the plate must act in the same way as our copper-zinc couple. We found such to be the case. If a plate so prepared be immersed in pure water, the decomposition of the liquid manifests itself by the reduction of the puce-coloured peroxide to the yellow monoxide. There could be little doubt therefore that the lead peroxide couple, if we may call it so, would decompose sulphuric acid, with the production of sulphate of lead. This also was found to be the case.

As the destruction of peroxide of lead means so much diminution of the amount of electric energy, it became interesting to obtain some definite knowledge as to the rapidity or extent of this action.

When the peroxide of lead on the metal is very small in quantity, its transformation into the white sulphate goes on perceptibly to the eye, but when the coating is thicker, the time required is, as might be expected, too long for this kind of observation. In one experiment, following the procedure of Planté, we formed the peroxide on the plate by a series of seventeen charges and discharges, or reversals, each operation lasting twenty minutes, and the time was further broken up by seven periods of repose, averaging about twenty-four hours in length. After the last charge we watched the local action taking place, and found that the whole of the peroxide passed into white sulphate within seventeen hours. In another experiment the two plates formed according to Planté's method were immediately joined up with the galvanometer, and the deflection noted. They were then at once disconnected. After the repose of one hour they were joined up again, and another observation taken with the galvanometer. This was repeated several times, with the following results:—

Initial strength of current	100
After 1 hour's repose	97
,, 2 ,, ...	40
,, 4 ,, ...	14
,, 17 ,, ...	1·5

It results from this that during each of the long periods of repose recommended by Planté the peroxide on the lead plate is wholly, or almost wholly, destroyed by local action, with the formation of a proportionate amount of sulphate. But this is not, as it would seem at first sight, a useless procedure; for, in the next stage, the sulphate is reduced by electrolytic hydrogen, and, by a process which we hope to explain when discussing the complete history of the reaction, the amount of finely divided lead capable of being peroxidised is increased. That this is actually the case is shown by the following experiment. The peroxide formed on a lead plate by first charging was determined and called unity: it was allowed to remain in a state of repose for eighteen hours, charged a second time, the peroxide again determined, and so on:—

Separate periods of repose.	Charge.	Amount of peroxide
—	First	1·0
18 hours	Second	1·57
2 days	Third	1·71
4 ,, ...	Fourth	2·14
2 ,, ...	Fifth	2·43

In other trials, following the procedure of Faure, we employed plates in which the peroxide was formed by the reduction of a layer of red lead (containing 51 grains to one square inch of metallic surface) and subsequently completely peroxidising the spongy metal so produced. In one series of experiments we left the peroxidised plates to themselves for various periods and determined the amount of sulphate formed. This gave us the amount of peroxide consumed.

Experiment I.	after 2	hours	7·2	per cent.
,, II.	,, 3	,,	15·1	,,
,, III.	,, 4	,,	19·8	,,
,, IV.	,, 5	,,	30·0	,,
,, V.	,, 24	,,	36·3	,,
,, VI.	,, 7	days	58·3	,,
,, VII.	,, 11	,,	67·3	,,
,, VIII.	,, 12	,,	74·3	,,

The last experiment was tested with the galvanometer during its continuance, as in the case of the plate formed by Planté's method, with the following results:—

Initial strength of current	100
After 1 days' repose	92
,, 3 ,, ,, ...	79
,, 4 ,, ,, ...	34
,, 5 ,, ,, ...	24
,, 7 ,, ,, ...	11
,, 9 ,, ,, ...	8
,, 12 ,, ,, ...	1

It is evident from these observations that a lead-peroxide plate gradually loses its energy by local action, and that the rate varies according to the circumstances of its preparation.

Two difficulties will probably present themselves to any one on first grasping the idea of this local action:—1. Why should a lead plate covered with the peroxide and immersed in dilute sulphuric acid, run down so slowly that it requires many hours or even days before its energy is so seriously reduced as to impair its value for practical purposes? In the case of the copper zinc couple immersed in the same acid, though the difference of potential is not so great, a similar amount of chemical change would take place in a few minutes. 2. In a Planté or Faure battery the mass of peroxide which is in contact with the metallic lead plate expends its energy slowly. How comes it to pass that if the same mass of peroxide be brought into connection through the first lead plate with another lead plate at a distance, it expends its energy through the greater length of sulphuric acid in a tenth or a hundredth part of the time?

The answer to these two questions is doubtless to be found in the formation of the insoluble sulphate of lead, which clogs up the interstices of the peroxide and after a while forms an almost impermeable coating of high resistance between it and the first metallic plate.

The following conclusions seem warranted by the above observations:—

In the Planté or Faure battery local action necessarily takes place on the negative plate, with the production of sulphate of lead.

The formation of this sulphate of lead is absolutely

requisite in order that the charge should be retained for a sufficient time to be practically available.

The rapidity of loss during repose will depend upon the closeness of the sulphate of lead and perhaps upon other mechanical conditions. These are doubtless susceptible of great modifications. We do not know how far they are modified in practice, but it is conceivable that still greater improvements may yet be made in this direction.

J. H. GLADSTONE
ALFRED TRIBE

STEUDEL'S NOMENCLATOR

ALL working systematic botanists use Steudel's "Nomenclator botanicus seu Synonymia plantarum universalis" as an indispensable book of reference. It is an alphabetical list arranged under genera of published names of plants, giving their native countries and the authors who published their descriptions. Synonyms are as far as possible given under the species to which they belong. The second volume of Steudel's work was published in 1841, and it is probably not far wrong to assume that the existing mass of described plants has since doubled.

Mr. Darwin has with equal kindness and generosity expressed the wish to aid in some way the scientific work carried on at the Royal Gardens, Kew. The attempt has been made for many years to keep up in the herbarium there a copy of Steudel with manuscript additions, for the use of persons engaged in the study of any particular group of flowering plants. By reference to the Kew Steudel it is possible to ascertain to a large extent what has been done, and so avoid the risk of describing and naming the same material twice over. But the Kew Steudel has only hitherto been posted up by the aid of funds privately supplied on intermittent occasions, and is not absolutely complete.

Mr. Darwin having had occasion to appreciate the usefulness of such a work in the botanical investigations which have of late years engaged his attention, has determined to supply the funds for preparing a new edition of Steudel's "Nomenclator," brought up to date. The work, which it is estimated will extend over about six years, will be carried on at Kew, and will be based on the limitations of genera laid down in Bentham and Hooker's "Genera Plantarum," to which it will in fact form a kind of complement. The editorial work has been entrusted to Mr. Daydon Jackson, Secretary of the Linnean Society. Mr. Darwin's munificent aid does not extend beyond supplying the means for preparing the work. The form and manner of publication will be reserved for consideration on its completion.

The Royal Gardens, Kew, have been very fortunate in from time to time receiving sympathetic aid from the outside world on behalf of the various branches of scientific work carried on in connection with them. The gifts of Mr. Bentham's library and herbarium, of the Jodrell Laboratory, of the North Gallery, and now of the means of preparing a new Steudel, are conspicuous examples.

FIRE RISKS OF ELECTRIC LIGHTING

IN an article published originally in the United States, and reprinted in our contemporary, the *Chemical News*, Prof. Henry Morton has called attention to the risks to which property is exposed from the increasing employment of powerful currents of electricity for electric lighting. The caution and the remedies suggested are assuredly timely when preparations are being made on so many hands for a vast extension of electric lighting. No fewer than five times did fire break out in the late Paris Exhibition, and in each of these cases the cause was the same, namely, defective insulation of the conducting wires. Prof. Morton divides the dangers into two kinds—those arising from the conductors, and those arising from the lamps. When naked wires are used as conductors, and when both are, as is sometimes the case, merely nailed or stapled to wall or floor side by side, there is a great chance that some stray scrap of wire, a falling nail or pin, may short-circuit the line and become red-hot in an instant. Loose wires are again a source of danger, as they may be momentarily short-circuited, and arcs set up of a dangerous nature at the point of contact. These remarks are specially cogent in such cases as those where many arc lights are being worked on a single circuit, and where there is of necessity a very high electromotive force employed. On such circuits, moreover, should some of the arcs go out, there is a risk of the others becoming excessive in power, risking the metalwork of the lamps, and thereby endangering a conflagration. Moreover, the lamps themselves are not free from danger, if so constructed that fragments of red-hot carbon can fall from them, as was the case not many months ago with one of the Siemens' lamps in the reading-room of the British Museum.

As a remedy to diminish such risks, Prof. Morton makes the following recommendations, every one of which we can heartily indorse. Firstly, that both the conductors—the outgoing main and the return wire as well—should be completely insulated; and that the machines and fixtures of the lamps should also be insulated, so far as regards all ground connections. Secondly, that the outgoing and return wires, instead of being laid side by side, should be separated as widely as possible. And he also recommends that, in the case of arc lamps in series, there should be automatic adjustments, to short-circuit a part of the current in case the arc in the lamp becomes too powerful, and to diminish the electromotive force of the generators in proportion to the actual resistances in circuit. Even on those systems of electric lighting which apply the principle of incandescence, where the electromotive forces employed are, as a rule, smaller than with arc lighting, there is need of caution. And one cannot too highly admire the ingenious device with which Mr. Edison has met most of the possible obtions beforehand, by interposing automatic "cut-off" joints of lead wire at every branch of the ramified circuit of his system of supply; the thickness of the wire being adjusted according to the circumstances of each case. It would be well for Fire Insurance Companies to lose no time in laying down a code of reasonable conditions to be complied with in case of buildings lit by electric lights. Without such precautionary conditions electric lighting is at least as unsafe as lighting by gas, and that is saying a good deal. But where proper precautions are taken, we think it should be a far safer mode of lighting; and should be recognised as such by the imposition of a lower insurance premium than is fixed in the case of lighting by gas.

THE MARKINGS ON JUPITER

DURING the present winter months Jupiter will doubtless attract a large amount of attention from the possessors of telescopes. Displaying a large and varied extent of detail clearly indicating that atmospheric phenomena of stupendous character are in progress on his surface, this planet at once claims notice on account of the ease with which his chief features may be discerned, and their singular anomalies of motion and appearance made manifest.

The large red spot situated immediately south of the great southern belt, and lying parallel with it, continues to present a well-defined boundary, indeed we must attribute to this remarkable formation a good deal of the interest which has been accorded to this planet since the first apparition of the spot in the summer of 1878.

It has now been visible for a period exceeding three years, and its conspicuous and decided aspect as it nightly crosses the central meridian of Jupiter, sufficiently predicates that its existence is likely to be prolonged a considerable time yet. The spot is elliptical in form with tapering ends; it occupies about fifty-five minutes in its entire transit over the centre of the illuminated disc. No distinct alteration in its appearance has been recorded during the last two years. Minor changes have probably occurred, though too minute to be appreciable, for when we consider the perpetual state of commotion under which the other markings exist, we cannot regard this particular object as absolutely free from similar influences, though they may have hitherto eluded detection. One of the most recent measures of the spot give it a length of 29,000 miles, and a breadth of 8,300, so that the length is to the breadth as 7 to 2.

The telescopic history of this planet contains many instances of fairly persistent spots having been observed and utilised as a ready means of determining the period of the planet's rotation. But the records of former years can furnish no parallel to the extent and accuracy of the modern observations. The old observers were in a measure isolated, and their work often lacked corroboration. Circumstances are now changed entirely. Observers have become far more numerous, astronomical appliances have been greatly improved, and the science has become more popular with increased facilities, so that where one powerful telescope was found half a century ago, there are at least ten at the present day. The result is that all attractive phenomena, such as planetary markings, are eagerly watched and recorded, so that interesting comparisons and confirmations, impossible in former times, are often the natural outcome. In regard to the large spot on Jupiter it is certain that no previous observations can vie with it either in completeness or precision, and it must obviously supply the data for determining the rotation period of Jupiter with a degree of reliance beyond all parallel.

Proper motion in the spot itself originates a slight diffi-

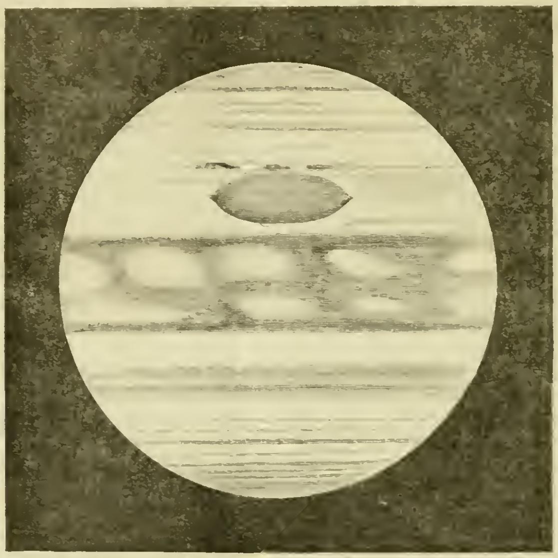

FIG. 1.—The great red spot in Transit, December 7, 1881, 1 h. 40m. There was a large white patch near the equator under the following side of the red spot. Immediately south of the red spot is a narrow belt with light and dark ovals upon it.

culty in adopting a period to satisfy the observations, and there is no doubt that similar independent movements in the objects observed were the cause of the differences in the periods assigned by various former authorities for the rotation which has varied from 9h. 49m. to 9h. 56m., and in truth it is doubtful whether we shall ever obtain the means of deriving the value with conclusive satisfaction. We can of course compute with nicety the periods of individual markings, but different ones have different periods. It is doubtful whether we can select the markings which are representative of the real period, for the spots are evidently influenced by a series of atmospheric currents which displace their relative positions on the disc in a very short interval of time. In the case of the great red spot, it has been surmised from its permanence and regularity of apparition that it very nearly represents the true rotating period of the planet's sphere, and it is gratifying to note that this element has been determined by several observers with excellent corroboration as follows:—

	h. m. s.	
Prof. G. W. Hough	9 55 35·2,	Sept. 79 to Jan. 27, 1881
A. Marth	9 55 34·47,	1878–81
J. F. J. Schmidt ...	9 55 34·42,	1879–80
H. Pratt...	9 55 33·91,	1879, July to December

These values are all within one second of the mean =9h. 55m. 34·5s. Several observers have remarked that the motion of the spot has slackened somewhat since 1879.

Turning now to the equatorial region of Jupiter, we shall find here not only a large extent of detail, but marked evidences of great and rapid changes. Immediately north and south of the equator there is a very well-defined dark belt, and between these are a series of

curious irregular shadings interspersed with brilliant white spots and light patches, which seem to be influenced by some abnormal phenomena. Watched from night to night, and their relative positions carefully determined, they are seen to vary considerably, and to travel much swifter than the red spot. The bright spots, which generally lie very slightly south of the equator and on the north border of the great south belt, are influenced by a rapid proper motion on the surface of the planet. In a single rotation of Jupiter they are displaced relatively to the red spot, to the extent of $3\frac{1}{4}°$, their period being $5\frac{1}{2}$ minutes less. In 1880 these white and generally oval spots were observed with a good deal of attention, and in a few marked cases the times of rotation were derived as follows:—

	h.	m.	s.
J. F. J. Schmidt	9	50	0
A. Marth	9	50	6·6
Prof. G. W. Hough	9	50	0·56
,, ,, ...	9	50	9·8
W. F. Denning	9	50	5

One bright spot in particular arrested attention as the most conspicuous of its class, and this object continues visible at the present time. Its independent motion enables it to make a complete circuit of Jupiter, relatively to the red spot, in $44\frac{1}{2}$ days. One of the most interesting points of observation is to note the changes in the relative positions of the spots on successive nights, and to watch the bright equatorial markings as they overtake and pass the red spot. In four days the white spots traverse an equivalent extent of longitude to that covered by the red spot, so that during this interval they travel from the *f.* end to the *p.* end of the latter object. The independent motion of the equatorial markings is the same in direction as that of the satellites and of the planet on its axis, namely, from west to east.

In the southern hemisphere of Jupiter there are several narrow dusky bands outlying the red spot, and a few dusky streaks or short belts of distinct form are manifest. In the north hemisphere there is a conspicuous double belt in about lat. 25°; the south side of this belt was

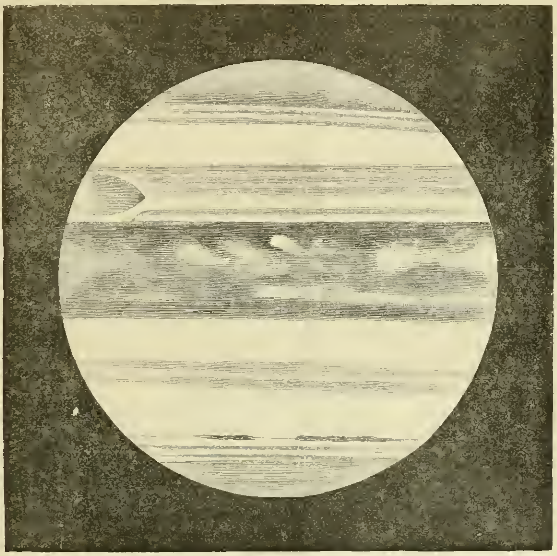

FIG. 2.—The bright spot in transit, December 18, 1881, 6h 12m. The following side of the red spot is seen on the western limb. To the east of the light spot, and in nearly the same latitude, is a dark mass emerging from the great southern belt.

formed by the outbreak and subsequent rapid development and dispersion of a series of dark spots during the months of October, November, and December, 1880. At first appearing as well-defined and almost as plain as the shadows of satellites in transit, they increased in numbers, or became greatly extended longitudinally, but gradually lost their decided character until they were eventually dispersed around the planet, and formed a dusky girdle considerably north of the equator. In fact the formation of a new belt on Jupiter had been going on under the eyes of observers.

As to the bright equatorial spot, it came to conjunction with the red spot on November 10, 1881, and the same objects were noted in conjunction on November 19, 1880, at 9h. 23m.. when crossing the central meridian of Jupiter. In the meantime the behaviour of the two objects has been very remarkable, for the red spot during the interval of 356 days has performed 861 rotations, while the light spot has completed 869, and has in fact travelled round the sphere of Jupiter eight times relatively to the position of the red spot! The two objects were again observed in the same longitude on December 24, 1881, at 9h. 43., having completed 967 and 976 rotations respectively. The next two conjunctions will occur on February 6, 1882, and March 23, 1882, after which they will not be well seen until the ensuing summer, when Jupiter again becomes visible in the morning sky, and the two spots, should they continue to be presented on the disc of the planet, will occupy nearly the same longitude on August 3, September 17, October 31, and December 14, 1882.

The diameter of the white spot is very variable, sometimes it is fully 2″, which corresponds to more than 4600 miles, but it is occasionally much contracted by encroachments

of the dark masses on the great northern belt. The spot is also liable to become very faint. I have carefully noted these variations, and though the observations are not sufficiently full to determine the period, if any, they show that the spot becomes faint almost to invisibility at intervals of about 56 days, and that increased brightness of the spot is accompanied with accelerated motion. I believe this particular object is a permanent feature on the planet, and that it lies far below the level of the dusky belts. Mr. Marth has determined from a discussion of the observations of 1880 and 1881 (to November) that the mean motion of the spot has been uniform, and this is important as a proof of its stability. My own numerous observations have led me to conclude that:—

1. It is self-luminous and light-emitting.

2. That it is a part of, or projection from, the actual surface of the planet.

3. That therefore it indicates the real rotation period of Jupiter, which is 9h. 50m. 6·6s. (= daily rate 878°·48), as deduced by Mr. Marth. The motion of the red spot shows a decided slackening, so that we cannot accept it as a reliable and invariable indication of the motion of the Jovian sphere with which probably it has no material connection.

These conclusions are supported by the fact that we cannot admit the idea of an object as permanent and conspicuous as the white spot, rushing on in advance of the already swift axial movement of the planet (as computed from the positions of the red spot) whereas we can more readily understand that atmospheric objects, such as the belts and red spot (which are forms of identical phenomena), would show a tendency to lag behind the rapid motion of the sphere. We must allow that there will be a failure of objects on the extreme outer envelopes of Jupiter, to keep pace with the tremendous velocity of objects on his real surface. The dusky belts, the red spot, and similar markings, are probably openings in the Jovian atmosphere, and the slackening motion of these objects is simply the indication that they are becoming more shallow than formerly, whence we may infer that the motion will continue to decrease until they are finally dissipated.

A comparison of my recent observations with those made by Gledhill and Welb in the years 1869-72, show that many of the features which they described and delineated (in the *Astronomical Register* and *Popular Science Review*) are still visible or have reappeared after an interval of obscuration. The great red spot may be the same object as Gledhill's ellipse of 1869-71. In many of the details visible then and now there is a remarkable similarity both in aspect and position, and the observers of Jupiter should further carefully investigate the physical appearance of the planet with a view to obtain more distinct evidence on the question of periodic variations. In this connection I may quote a remark by the late Mr. Lassell (*Monthly Notices*, vol. xxxiv. p. 310), where, in referring to round light spots he saw on Jupiter in March, 1850, and March, 1874, he says: "I believe the appearance of these spots is very rare, as I have not seen them for many years, and the general similarity of the aspect of the planet now [1874] and then [1850] suggests the idea that the various phases return in cycles, which I think more probable than that absolute secular changes occur in the heavenly bodies within the limit of time of any human records." W. F. DENNING

LITTLE ELECTROMOTORS

THE probability that within a few months almost every large town and city will be supplied with electricity on a large scale for the purpose of lighting, has brought into prominence the question of utilising the same supply for the purpose of producing power on a small scale for sundry domestic purposes. There are a number of objects for which machinery is employed, though on so small a scale that it would not be worth while to set up a steam-engine or gas-engine to drive it, to say nothing of the inconvenience of a steam- or gas-engine in a private house. To drive a sewing-machine, for example, or to work a light turning-lathe, requires a comparatively small power, and usually only for a limited time. It is natural then to think that when the power of electricity is available in the wires which supply electric light, such a power, especially as it is so simply and readily controlled, might be economically employed for such purposes.

But to drive machinery by electric currents necessitates the employment of the appropriate electric engine or "electromotor," which, as its name implies, is an engine which, by the expenditure of electrical energy, does mechanical work. Such engines have been known since 1831, when Prof. Henry first constructed a rotating engine driven by electromagnets. Ritchie, in 1833, independently constructed an electromagnetic apparatus for producing continuous rotation. Fig. 1, which we borrow from Prof. S. Thompson's "Lessons in Electricity and Magnetism," shows a modification of Ritchie's electromotor frequently found in collections of electrical apparatus. It consists simply of an electromagnet, C D, poised upon a

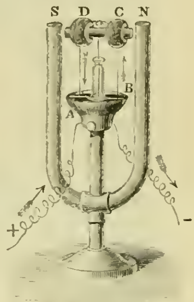

FIG. 1.

pivot between the poles, N S, of a steel horseshoe magnet, and fitted with an arrangement of mercury cups, A B, as a commutator, by means of which the current arriving through the wires is so directed through the coil as to produce motions, in one sense, only round the axis. The pole C of the electromagent is attracted round toward S until, just as it nears S the wire beneath C passes from one mercury-cup to the other, so reversing the current and causing C to be repelled from S and attracted to N.

To speak of the further developments of these machines in the hands of Jacobi, Sturgeon, Froment, and others, would be to traverse ground too wide for the scope of an article like this. Paccinotti's discovery of the ring-armature, which in 1869 he applied to the construction of an electromagnetic motor which was also capable of being used as a generator of currents, dropped strangely out of sight. And the subsequent discovery of M. Gramme that his generator would work as a motor was only the beginning of a new epoch in the history of electromotors. We know that all the magneto-electric and dynamo-electric machines used to generate continuous currents of electricity, whether of Gramme, Siemens, Brush, or Edison are *reversible*. If we drive them by mechanical power they yield electric currents, and if on the other hand we supply them with currents of electricity, they can run backwards and do work for us. Sawing and ploughing are now done every day by this means. We have Siemens' electric railway and tramway, and many other useful applications of the same principle, of which

one of the newest and most interesting is Dr. Hopkinson's electric elevator or "lift."

But to come back to the application of power on the very small scale adapted for domestic purposes; several *small* motors exist, each of which can do excellent work. The earliest of these small modern motors is that of M. Marcel Deprez, invented about three years ago, and which consists (see Fig. 2) of a single Siemens armature, A B, of the old well-known type, placed longitudinally between the poles of a horse-shoe, or rather a U-

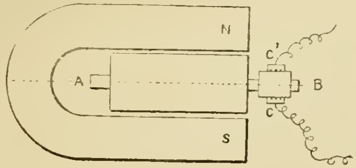

FIG. 2.

shaped steel magnet. The advantage of this arrangement is that the position of the armature utilises the whole field of force which lies between the limbs of the magnet. A large number of these little motors were set up by M. Marcel Deprez at different points of the galleries of the late Paris Exhibition in illustration of the possibility of distributing power from a central source. Two other forms of motor have more recently claimed attention. The first of these is the invention of M. Trouvé, and differs from that of M. Marcel Deprez in having an electromagnet instead of a permanent steel magnet to produce the field of magnetic force within which the armature is placed. The armature is also longitudinal and of the Siemens' type, with a slight modification, suggested by M. Trouvé, with the purpose of getting a more continuous action.

Fig. 3 shows how such a little motor may be attached

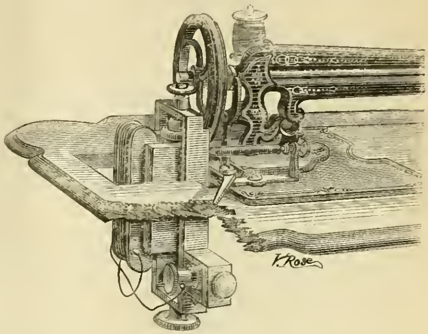

FIG. 3.

to a sewing machine. The axis of the armature is here vertical and carries a small disk or wheel of india-rubber which, when the motor is clamped in position, presses against the driving wheel of the sewing machine with a contact sufficient to enable it to drive the machine; a

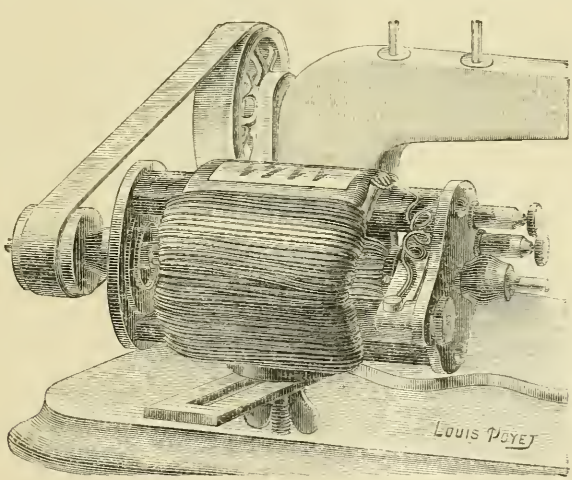

FIG. 4.

work which in spite of the small dimensions of the motor it accomplishes readily, on account of the high speed with which it runs. No steam-engine so small could possibly do the work without great loss, since steam will not give up its heat at an indefinitely great rate. It is said that three of Faure's accumulators weighing 50 lbs. each may, when fully charged, drive a sewing machine by a Trouvé motor for a whole week, working five or six hours every day. Motors similar to this have been fixed by M. Trouvé in his little electric canoe, and are suggested by M. Tissandier for balloon steering.

The favourite motor, however, at the present time appears to be that of Griscom, an American electrician, whose English agent is Mr. Paterson of Little Britain, and which we depict in Fig. 4. This elegant little machine is only $4\frac{1}{2}$ inches long, and weighs a little over two pounds only. But it is remarkably powerful and steady in its action. It can, when fed with a current of

requisite strength, rotate at a speed of 500 revolutions a minute. and in that time will do from 22 to 29 foot pounds of work. The construction is extremely simple. There is a Siemens' armature on a horizontal axis, within, and entirely surrounded by, the fixed electromagnet which not only serves to produce a powerful magnetic field, but also acts as a rigid framework for the rotating parts, which is thus protected from injury. The contact of the wires of the circuit with the commutator is made by two springs with little metallic friction-rollers at the end. The ironwork is made of malleable cast-iron, and so combines the advantage of high magnetic power and of cheap production. Mr. Griscom, the inventor, styles his little machine the double-induction motor on account of the reaction between the currents in the armature and those which supply the outer field-magnets. The inventor originally intended his motor to be used with a 6-cell bichromate battery, and he claims that one single charge of acid liquid will last long enough to enable a sewing-machine fixed to a motor to accomplish from 500 to 1000 yards of stitching. But there is no doubt that the motors work equally well with currents supplied from any other source in adequate strength. A gold medal was awarded at the late Paris Exhibition to Mr. Griscom for the excellence of his capital little machine.

It will be remarked that in each of the little modern motors described a simple Siemens' armature is employed in preference to one in the form of the Gramme ring or other complicated pattern. This is simply a consequence of the difficulty of constructing these more complex kinds of armature cheaply on a small scale. If they could be as cheaply constructed they would doubtless be preferable as having no dead points, and therefore not being liable to stick at starting, though this rarely happens with these little electric engines. It will also be noted that the last two forms are dynamo-electric instead of magneto-electric; that is to say their fixed magnets are electro-magnets of iron, not permanent magnets of steel. This is in order to gain space; for an electromagnet may be made far more powerful than a steel magnet of equal size, and therefore for an equal power the electromagnet will be of less bulk than the magnet of hard steel.

A CHAPTER IN THE HISTORY OF CONIFERÆ

THE PODOCARPEÆ

THE tribe is limited to three genera. Nothing is known as to the ancestry of two of these—*Microcachrys* and *Saxegothea*, represented now by a single species each; but the third, *Podocarpus*, comprises fifty-nine species according to Gordon.[1] The fruits are drupaceous or nut-like, and the seed generally possesses a hard shell and contains a dicotyledonous embryo. The leaves are either distichous, like the yew, or imbricated, and vary from very small to several inches in length; and although generally parallel-nerved, two species in the Kew Herbarium have distinctly dicotyledonous venation. Like the rest of the Coniferæ, some species form colossal trees, exceeding 200 feet in height. They are classified in the "Genera Plantarum" into four groups—*Nageia*, which contains the only Conifer indigenous to the East Indies; *Eupodocarpus*, comprising the vast majority of the species; *Stachycarpus*, and *Dacrycarpus*. The two latter sections are represented in the Eocene, and are at present limited to the Malay Archipelago, Australia, New Zealand, and South America. Notwithstanding their immense distribution and the evidence of vast antiquity which the genus presents, scarcely anything is known of their past history. In most cases the foliage when detached has little to distinguish it from better-known Coniferæ, and the fruits, in the fossil condition, seldom present anything by which their gymnospermous origin can be inferred. Except a doubtful and undescribed species from Aix-la-Chapelle, no podocarp is known of earlier age than Eocene, and they disappear from temperate Europe with the Oligocene. Like the Araucaria and other genera innumerable, they seem to oppose the theory that all plants have originated in northern regions, and passed south by way of existing continents; and unless it is supposed that their present distribution was accomplished prior to the Cretaceous, we are forced to admit, in order to explain their presence in Chili and other parts of South America, a land connection far to the south of that admitted by Wallace and those who share his opinions. No trace of podocarp has in fact been made known either from the Arctic or the American Cretaceous and Tertiary floras.

The fossil Podocarps that are known may be conveniently classified under two heads—those that have shed their leaves separately, and those that have shed them adhering to branchlets.

Of the former, various species have been described by Saporta, Heer, Unger, Ettingshausen, and others, ranging in time from the Suessonian to the lowest stage of the Aquitanian. They therefore form a group in Central Europe essentially characteristic of the Eocene, and are quite unknown in the Miocene, except in Italy. They occur at Aix, Lat. 43°, and extend up to about Lat. 48°, which represents their Eocene distribution as at present published. It may therefore emphasise the importance attaching to a proper examination of our British Eocene floras, when I state that they have now been found not only at Bournemouth, but in Antrim and in Mull, or as far north as about 56½°. The British species differs from all those previously figured, for it has a broadly sessile and articulated base, whilst the others are represented as tapering to a fine point. The leaves, though scarcely 2 mm. broad, sometimes reach 5 inches in length. Those from Mull, and, as far as can be seen, the half-leaf from Antrim, are specifically identical with the Bournemouth form, and this is the more remarkable since the latter is confined to the uppermost bed under the Coastguard Station, and has never been found in any of the other numerous beds from which I have so largely collected. Of the Continental species, the nearest to it are mostly from Aix, whose flora in several other respects presents the greatest affinities with ours. Besides the identity in appearance of some of the leaves with many existing Podocarps, as *P. andina*, the microscopic structure of the leaves and wood peculiar to them was recognised and explained by Unger. I have not seen any records of the fruits being found, and although some from Bournemouth might belong to the species, no essential character is preserved.

Of the Podocarps whose leaves are shed attached to branchlets, only the most insignificant traces have been hitherto known. I have now to add at least two species whose foliage, fruit, and flowers are preserved.

The first and most ancient is from Alum Bay, and has hitherto been supposed a Sequoia, a Taxus, a Cypress, &c., by distinguished Continental professors who have examined it. Possessing polymorphic foliage, it falls into the "Dacrycarpus" division of Hooker. By far the larger proportion of the foliage collected is distichous, being much smaller than that of the yew, with the bases of the leaves prolonged down and adhering to the stem, and with three out of the five rows, though still recognisable, reduced to small dimensions. This abortion of some of the leaves, in order to permit the remainder to expand into two lateral rows, is exceedingly characteristic of ancient Coniferæ, and still survives in Sequoia, being probably the precursor of the truly distichous arrangement seen in Taxus, Taxodium, Toveya, and other existing Conifers. The fruit is small, petiolated, and remarkable as occurring on the distichous branches. The fossils of Alum Bay were, unfortunately, collected principally for sale, and the unattractive imbricated branchlets and the insignificant-looking fruit were doubt-

[1] Sir Joseph Hooker believes they may eventually be reduced to less than orty, since several are very imperfectly known.

less passed over. The fruit I possess is attached to a branch, and was found during the last visit to Alum Bay on which I was able to collect any fossils, for within a few months of that time the leaf-bed disappeared with the recession of the cliff. It is the only Conifer known from Alum Bay, or even from the Lower Bagshot formation, and all others should be erased from the list.

The second species is from Bournemouth, and is known from even more ample material. The foliage is also dimorphic, the distichous type being however very subordinate and confined, as in *P. cupressina* and other living species, to short, simple branchlets. A complete seedling plant with its roots possesses an irregular distichous foliage something like that of the Alum Bay species, but becomes imbricated towards the root. The young plant seems to have retained this character for some time, as shown by several branchlets. It then appears to have assumed a semi-imbricated foliage, which is exceedingly graceful. The full-grown tree principally possessed imbricated foliage, and the position the distichous branchlets occupied can only be inferred from existing allies. The largest branch is about fifteen inches long, and is composed of about thirty branchlets; but this is surpassed in elegance by another seventeen inches long, whose stem is still imperfect. The simple branchlets are very slender, about six inches long, and were often shed singly, but both branches and branchlets, as I here term them, were, I think, articulated and shed naturally, and not broken off by wind. The fruit is a berry of about half an inch diameter, clustered in three, shortly stalked, and borne on an imbricated branch, and the male catkins are in pairs and terminal. The tree was probably of large growth, and pendulous. A third form, which I cannot assign with equal reason to any genus but Podocarpus, has larger foliage. Both of these types seem extinct, with their nearest allies in the Australian region and the Oriental Island region of Wallace.

In addition to these there are fruits from Sheppey which I believe to be podocarpous, one at least seeming identical with *P. elata* of Queensland. The whole of the forms will be published and fully illustrated by the Palæontographical Society in their usual exhaustive manner.

The study of the Tertiary Coniferæ, together with that of the ferns, has already led to some not unimportant rectifications. The Bovey Tracey beds have been exactly correlated with those of Bournemouth, and now the Mull, and I believe also the North of Ireland beds, can be clearly shown to be Eocene. I also hope in my next journey to Iceland to complete the correlation of the Tertiary beds there, and of Scotland and Ireland, with those of Greenland, which I cannot but regard, from whatever aspect they are viewed, as of considerably earlier age than Miocene.

J. STARKIE GARDNER

NOTES

WE are glad to see in the recently published number of the *Journal* of the Linnean Society Mr. Bentham's important paper on the *Gramineæ*, giving the critical results of his examination of the leading groups and genera of that important family. Having been read so recently as November 3, 1881, it has been printed and issued to the Fellows with commendable rapidity. We understand that our distinguished English botanist is, notwithstanding his recent severe domestic affliction and his advanced age, in excellent health, and that he is daily engaged in the Herbarium of the Royal Gardens, Kew, in the continued preparation of the *Genera Plantarum*—the monumental work on the genera of all known flowering plants, of which the first instalment was published in 1862. Sir Joseph Hooker and Mr. Bentham have been occupied with its elaboration for the last quarter of a century, and it will be with feelings of no small satisfaction that all students of systematic botany will learn that the printing of the third and concluding volume will shortly be commenced.

MESSRS. MACMILLAN AND CO. will shortly publish an account of the late Prof. James Clerk Maxwell, by Prof. Lewis Campbell, of St. Andrews, and Mr. William Garnett, late Fellow of St. John's College, Cambridge. We understand that Prof. Campbell was Maxwell's intimate associate in early life, and Mr. Garnett was associated with him as demonstrator at the Cavendish Laboratory from its opening in 1873 until Prof. Maxwell's death in 1879. The work will consist of (1) a biographical outline by Prof. Campbell, with selections from correspondence; (2) by Mr. Garnett, a popular account of Maxwell's chief contributions to science; and (3) a collection of his poems, a few of which are already known to the public, while the greater number of them will now be published for the first time. The book will be illustrated with one or more steel plates of portraits, and a series of outline sketches of early scenes, done by Prof. Maxwell's cousin, Mrs. Hugh Blackburn (J.B.), from drawings made by herself at the time; also with coloured and other diagrams explanatory of his scientific work, some of which are taken from original water-colour sketches of his own. Not to dwell here on Prof. Maxwell's eminence as a man of science—the originality and depth of his character, his religious earnestness, his amiability, and his quaint ironical humour, may be expected to render this presentation of him by intimate friends more than ordinarily attractive to many readers outside the scientific world. The whole will be comprised in an octavo volume of about 500 pages.

UNDER the direction of the Trustees of the Gilchrist Educational Trust a course of scientific lectures by Mr. Lant Carpenter has just been given in five Lancashire towns. The total audiences were from 3500 to 4000 per week, chiefly artizans, who maintained their interest to the very end—the same people coming night after night—and in some instances going to another town in the same week to hear the lecture over again. The lectures were well illustrated by experiments and by the photographic diagrams, &c., in the oxhydrogen lantern. The latest developments of science were treated of, including the storage of energy and the electrical transmission of power. At the close of the course, hearty votes of thanks (with requests for other courses) were passed to the Gilchrist trustees and to the lecturer.

THE staff of the Russian observing station on the Lena left St. Petersburg on December 27. MM. Yurgens and Eigner are intrusted with the astronomical, magnetical, and meteorological observations, and Dr. Bunge will make researches in zoology, botany, and geology. They expect to reach Irkutsk with their instruments, in two months, and to begin next spring their journey to Yakutsk, so as to be able to open the polar station at the mouth of the Lena, on August 1, 1882.

THE rate of the cricket's chirp varies with the temperature, becoming faster as the latter rises. Recently a writer in the *Salem Gazette* (Mass.) gave the following rule for estimating the temperature of the air by the number of chirps made by crickets per minute:—"Take seventy-two as the number of strokes per minute at 60° temperature, and for every four strokes more add 1°; for every four strokes less deduct the same." In a letter to the *Popular Science Monthly*, Margarette W. Brook gives an account of observations she made with a view to testing this rule, on twelve evenings, from September 30 to October 17. Her column of temperatures as computed by the rate of vibration shows a close agreement with that of temperatures recorded by the thermometer.

THE industrial manufacture of oxygen has engaged much thought, while the uses, on a large scale, of that agent have not been very exactly determined. At Passy there are now works

for producing the gas according to an improved method of MM. Brin frères, who attach the highest value to oxygen as an industrial agent, and indicate various applications of it. The process is the well-known one in which caustic baryta absorbs oxygen from the air, and gives it up under heat. By a special way of preparing the baryta, however (described in *Annales Industrielles*), they render it highly retentive of its absorbent power, obviating the necessity of frequent renewal. After 400 operations there was (on microscopical examination) no appreciable change. The baryta is placed, at Passy, in metallic retorts connected, in groups of fifteen, in two furnaces heated with gaseous fuel. A locomotive engine drives Root blowers, which force air into the retorts; after peroxidation the oxygen is liberated by heat, and pumped into the gasometer through an apparatus which removes traces of carbonic acid. As it is found that the peroxidation takes place better with moist than with dry air, the air is passed through a saturator on its way to the retorts. For production of 5000 cubic metres of oxygen a day in Paris, it is estimated (from the data at Passy) that the cost per cubic metre would be from 0·12 to 0·15 franc, according as coal or coke was used for fuel. The price of 100 kilogr. of baryta prepared by the new method is about 250 francs.

MILITARY surgeons are familiar with the remarkable attitude retained by soldiers who have died on the battle-field. Recent experiments by M. Brown-Séquard (*Comptes rendus*, December 26) throw some light on the phenomenon. It is proved (1) that a true muscular contraction may occur a certain time after as well as before death, and that this contraction may last long, and pass into the state of cadaveric rigidity, or disappear completely, so that one may then recognise the persistence of muscular irritability; (2) that of the different parts of the brain, the cerebellum has most power of producing contraction after death; (3) that the retention, by soldiers killed on the battle-field, of the attitude they had before death, depends not on a sudden occurrence of cadaveric rigidity, but on the production of a true contraction.

IN a paper lately read before the Royal Society of Tasmania, Sir J. H. Lefroy gives a new determination of the magnetic declination—8° 49'·3 E.—at Hobart for the year 1881, which he had made on the site of the old magnetical observatory of 1840-48. He notes the observation of Tasman in 1642, that "near the coast here" (Tasmania) "the needle points due north," and comparing this with the values obtained by some modern observers since 1840, he concludes that the declination which had been increasing up to the time of the magnetic survey made by Dr. Neumayer in 1863, is now decreasing. At Melbourne it has also been observed that the declination has been decreasing since 1865.

THE University of St. Petersburg has had added to it an astronomical observatory for the students. Until now the students who wished to learn practical astronomy have been reduced to make use of the very old observatory of the Academy of Sciences, with its old instruments and a complete want of any accommodation for study, or to find some friend among the officers of the Military General Staff Academy, who study at Pulkovo. Now St. Petersburg has a fine observatory, and will have an assistant-professor especially for this subject.

ST. PETERSBURG is to have its Electrical Exhibition, organised by the Technical Society. Several manufacturers of electrical apparatus and several Russian inventors have already promised their co-operation.

A VOLUME of considerable interest has recently been published by Friedenchsen and Co. of Hamburg—"Dr. Ludwig Leichhardt's Briefe an seine Angehörigen," edited by Dr. G. Neumayer and Otto Leichhardt, a nephew of the unfortunate Australian explorer. These letters are of special interest at present, when rumours come from Australia that the journals and other traces of Leichhardt have at last been found. The letters extend from 1834 (Göttingen) to April 3, 1848 (Macpherson's Station, Fitzroy Downs). These letters give one a high opinion of Leichhardt's qualifications for the work of exploration. He had an excellent education not only at home, but during lengthened residences in London and Paris. He had a strong love for natural science, was a shrewd and accurate observer, and a writer of considerable graphic power. His account of life in London and Paris is decidedly interesting, and his letters from Australia during his exploring work lead one to feel that the death of the writer was a real loss to science. These letters were quite worth publishing. Appended is a long paper by Dr. Neumayer on Leichhardt as a naturalist and explorer, in which the writer justly gives a high estimation of his qualifications and character.

THE Association for the Improvement of Geometrical Teaching will hold its annual meeting at University College, Gower Street, W.C., on Wednesday, January 11, at 11 a.m., when amongst other business the Code of Rules drawn up last April will be submitted for confirmation. The following resolutions will be proposed: That the proofs of the propositions contained in Book I. of the Syllabus will be received by the Association; and that the Committee for Elementary Plane Geometry be instructed to add a collection of exercises to the proofs of the propositions of the Syllabus. All persons interested in the objects of the Association are invited to attend.

THE number of visitors to the Royal Gardens, Kew, during the year 1881 was 836,676, the largest hitherto recorded.

AMONG the special articles in the *Annuaire* of the Brussels Observatory for 1882 are the following:—A list of 2000 communes in Belgium with their altitude according to the official survey; a paper on the conformation of the terrestrial globe; a series of studies of sun-spots in their various relations, by M. R. Tamene; tides on the coast of Belgium, by F. Van Rysselberghe; asteroids and comets discovered in 1881, by M. L. Niesten.

MR. E. C. OZANNE, of the Indian Civil Service, at present a student at the Royal Agricultural College, Cirencester, has been appointed Director of Agriculture in the Presidency of Bombay.

A SCHEME is on foot, having been approved by the Municipal Council of Paris, for extensively lighting with electricity the quarters of the Prefecture of the Seine, in the Tuileries. It is the work of M. Cernesson, and comprises lighting the Salle des Séances with eighty Swan lamps (in place of eighty Carcel lamps), and six Siemens' arc-lamps; lighting the library with forty-eight Maxim incandescent lamps (on the present lustres); another room with twenty-four Lane-Fox incandescent lamps; another with twenty Swan lamps; the Salle des Pas Perdus with two Werdermann lamps; a lobby with two Siemens' lamps, and a staircase with four Brush lamps. The whole will require an outlay of 75,000 francs. The horse-power necessary is 44, and while the idea of obtaining this from the Seine has been considered, it has been decided to set up a gas-engine in the court of the Tuileries. A portion of the motor force is to be employed for electric hoists, for driving ventilators, and other uses.

FROM the Annual Report of the Government Botanical Gardens at Saharunpur and Mussooree for the year ending March last, we gather the following facts:—On the collection and preparation of drugs, which seems to be an important item in the work of the establishment, it is stated that an indent for 200 lb.

of Taraxacum extract from the root of the Dandelion (*Taraxacum officinale*) was received from Calcutta. To supply this demand, which was the first occasion on which Taraxacum extract was supplied from the Saharunpur Garden, the seeds were sown over about half an acre of land in August, and the roots were dug up during the month of March and thoroughly dried in the sun, after which they were reduced to fine powder, this powder was then put into water and allowed to stand one night. The mixture was strained through fine cloth, and the clear liquid was then heated in a water bath until it had acquired the proper consistency. During the heating process a certain quantity of rectified spirits of wine was added to the extract. The heating process being finished, the extract on becoming cool was put into suitable jars and despatched. Of the Chuffa or Earth Almond, the tubers of *Cyperus esculenta*, a native of South Europe and North Africa, Mr. Duthie reports that about two dozen tubers have been received from Dr. Schomburgk, of Adelaide, and of this number about one-half had started into growth and were thriving luxuriantly. The tubers of this plant are used as an article of food in Egypt and in some parts of Europe, and they are now recommended for feeding sheep, hogs, poultry, &c., for which purpose they are largely used in the Southern States of America. Of Lucerne (*Medicago sativa*) it is stated that the demand for seed is every year increasing. "In addition to its good qualities as a fodder plant for horses and oxen it has the further advantage of being a perennial, which is very little affected by the extremes of heat and moisture it has to endure in North India. The Argan (*Argania sideroxylon*), a valuable oil-producing tree of Morocco, has been received at Saharunpur, and every care will be taken with the plants should the seeds germinate. Mr. Duthie says, "I find from a list published in 1854 by the late superintendent, that the tree then existed in the Saharunpur Garden. As none of the original trees are now to be found it would appear that the climate of this part of India is not altogether suitable."

UNDER the title of a "Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Indiana" we have received a small octavo pamphlet, giving as we believe the first complete catalogue of the flowering plants and ferns of the well-known State of Indiana. The flora numbers 1432 species referred to 577 genera, and no doubt further additions will from time to time be made. The authors of the useful flora are the editors of the *Botanical Gazette* of Crawfordsville (J. M. and M. S. Coulter) and Prof. C. Barnes.

THE last number of the *Zapiska* (Memoirs) of the Caucasian branch of the Russian Geographical Society contains a valuable paper by the late P. K. Ushar, on the "Oldest Traditions on Caucasus."

WE have just received the first part of a second series of Dr. C. Fr. W. Krukenberg's "Vergleichend-physiologische Studien," Heidelberg, 1882. This part, of over 180 pages, is taken up with a number of very important and interesting memoirs, on such subjects as "On the Temperature at which the Lymph of Invertebrates Coagulates," "On the Colour Substance of Feathers," "On the Protective Coverings of the Echinoderms," &c.

THE Polytechnic has at last been sold, and will finally close on January 21. Until then a varied programme will be presented daily, including new musical, optical, magical, and popular scientific entertainments, as well as a *réchauffé* of very many of those that have been characteristic of the place during the last twenty years.

A VERY favourable Report is to hand of the Sheffield Free Public Libraries and Museum. Many additions have been made to the latter, and the small observatory attached, and which is open to the public, was visited during the year by about 3000 people.

ON December 29, 1881, two strong shocks of earthquake were felt at Kiangari, in the province of Kastamoumi. The movement was from east to west. Considerable damage was done to the village, but no details have yet been received at Constantinople.

WE have received from the Society of Telegraph Engineers a list of the additions to their library during the past year; this library, we may remind our readers, is now open to the public.

THE Waterford Literary and Scientific Association have begun to publish their Proceedings. The part for 1880-81 contains abstracts of various lectures and papers, and the fifth Annual Report records the steady success of the Association.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mr. Wm. Trent; a Marsh Ichneumon (*Herpestes galeri*) from South Africa, presented by Mr. Ernest Wells; an Indranee Owl (*Syrnium indranee*) from Ceylon, presented by Commander Burkitt; a Short-toed Lark (*Calandrella brachydactyla*), British, presented by Mr. H. A. Macpherson; a Pike (*Esox lucius*), British fresh waters, presented by Mr. George Seaton; a Malbrouck Monkey (*Cercopithecus cynosurus*) from West Africa, a Kinkajou (*Cercoleptes caudivolvulus*) from Brazil, a Black-footed Penguin (*Spheniscus demersus*) from South Africa, deposited; a Kusimanse (*Crossarchus obscurus*) from South Africa, a White eared Conure (*Conurus leucotis*) from Brazil, a Blue crowned Parrot (*Tanygnathus luzonensis*) from the Philippines, purchased; a Molucca Deer (*Cervus moluccensis*), born in the Gardens.

PHYSICAL NOTES

THE vapour-tension of liquid mixtures has been lately investigated by Herr Konowalow (*Wied. Ann.*, No. 9) in the case of the first four members of the alcohol and the acid series, each mixed, in various proportions, with water. Curves were obtained by taking the percentages as abscissæ and the tensions as ordinates. The author finds that each mixture, to which a maximum or minimum of tension corresponds, has, at the temperature indicated, the same composition as its vapour. Thus liquid mixtures, with reference to distillation, are divisible into three groups—(*a*) Those whose curve of tension has neither a maximum nor a minimum; (*b*) Those whose curve has a maximum (*e.g.* propylic alcohol, butyric acid); (*c*) Those whose curve has a minimum (*e.g.* formic acid). Herr Konowalow shows, from a table of all the constant boiling mixtures known to him, that in all the boiling temperature of the mixture is either greater or less than those of both constituents, *i.e.* all the tension-curves have a maximum or a minimum. The existence of such a point seems, thus far, to be a necessary condition of the existence of a constant boiling mixture. These mixtures have not, apparently, a simple molecular constitution.

IN his study of sulphur Saint-Claire Deville obtained (from flowers of sulphur) a variety more stable than those known, and insoluble in sulphide of carbon; its form being that of a fine powder, each grain a hollow vesicle. He failed to find the specific gravity of this vesicular sulphur, and suggested to M. Spring, about a year ago, to subject the material to the powerful compressing apparatus used in his recent noteworthy experiments. This has been done (*Bull. Belg. Acad.* No. 8), with a pressure of 8000 atmospheres for a few seconds and temperature of 13°, producing hard pale yellow blocks. Treatment with sulphide of carbon showed that 4·21 per cent. was transformed into octahedral sulphur, so that the density of the vesicular variety is less than that of the other. M. Spring further directly determined the specific gravity of those blocks at different temperatures, measuring the expansion; and by calculation he reaches the result that vesicular sulphur has probably the same specific gravity as prismatic sulphur (1·960). It was also observed that vesicular sulphur dilates regularly under heat up to 43°, beyond which it contracts continuously, till at 80° it has the same specific

gravity as at zero. This contraction M. Spring thinks probably due to transformation of vesicular into octahedral sulphur

In another paper to the Belgian Academy (*Bull.* No. 8) M. Spring concludes that there is a relation between the dilatation and the atomic weight of simple substances; for certain of them, as sulphur, selenium, and tellurium, nickel and cobalt, iron and aluminium, the former is inversely proportional to the latter. Otherwise expressed, the dilatation per atom (in the groups specified) is constant. The possibility is thus suggested of determining the number of atoms contained in a molecule of a solid substance. M. Spring is investigating this.

Prof. W. Holtz, inventor of the well-known Holtz electrical machine, has recently studied the various possible ways of arranging the inductors and armatures of his machine. This research was undertaken with a view partly to investigate the action of the analogous machine of Töpler, in which the fixed plate is not pierced as in the Holtz machine, and partly to ascertain the reasons for the shifting brushes of light to be observed in the ordinary Holtz machine. The research, which is too lengthy to reproduce here, led to the conclusion that there is an advantage in the apertures of the fixed plate.

To charge the electrodes of a secondary battery to their maximum potential requires a quantity of electricity roughly proportional to their surface. But if the source from whence the charge is derived is of an electromotive force inferior to this maximum, then the polarisation-charge is limited, not by the surface of the electrodes merely, but by the fact that the opposing polarisation completely stops the current. M. Blondlot has lately determined the quantities of charge required to polarise to such a limit a voltameter of given electrodes, when the electromotive forces are also of given magnitude. This was done by using a voltameter with very small electrodes, and including in the circuit with it a battery, a ballistic galvanometer, and an apparatus for closing circuit during a determinate fraction of a second. By the device of increasing the area of one or other of the electrodes, M. Blondlot was able to study independently the two cases of polarisation by oxygen and of polarisation by hydrogen. The author further shows (*Journal de Physique*) that the elementary capacity of an electrode for a given electromotive force does not depend on the nature of the electrode. The latter is also proved by a single qualitative experiment. It follows that to charge, by an instantaneous polarisation, the electromotive force between an electrode and electrolyte of value e_1 to a value e_2, the same quantity of electricity is always required, whatever the chemical nature of the electrolyte. Further, the charge of the double electric layer at the surface of contact of an electrode and electrolyte does not depend on the nature of the electrolyte if the electric difference remains the same. M. Blondlot has also given an absolute measure of the initial capacity of platinum in water acidulated by sulphuric acid, and shows that this capacity may vary under different influences.

GEOGRAPHICAL NOTES

The *Journal* of the Geographical Society of Tokio for the year 1881 has just been published. It is printed wholly in the Japanese character, and its contents are therefore inaccessible to all but a very few European readers. Besides reports of the meetings, and some other official information, it contains a paper on Saghalin and the Kurile Islands, and one on the historical geography of Japan. Some Japanese who have travelled in China have formed themselves into a society for publishing a topographical description of that country. This will contain little that will be new to English readers, as no Japanese has, we believe, penetrated into Central Asia from the side of China. The Japanese have given us much new information respecting Corea, but they have as yet added little else to our geographical knowledge.

Mr. E. C. Hore's paper on Lake Tanganyika forms the staple of the January issue of the Geographical Society's *Proceedings*. The two maps which Mr. Hore furnishes are a valuable addition to the cartography of the lake, which is now for the first time delineated with any pretence to accuracy as a whole. The map of the southern part of the lake, Livingstone's Lake Liemba, is on the scale of five geographical miles to the inch. Mr. Markham's paper on the *Jeannette* expedition and Commodore Jansen's notes on recent Dutch Arctic voyages, and Mr. Leigh Smith's probable position we have already referred to at some length, and in connection therewith need only add that a map is now given of Wrangel Island from Lieut. Berry's survey. The geographical notes bring us some interesting news of African exploration, chiefly on the east side of the continent, and hold out the hope of a future paper on the little-known interior of Mozambique by a new traveller.

The first seven sheets of the large map of Eastern Equatorial Africa, with the preparation of which Mr. Ravenstein was entrusted in 1878 by the Council of the Geographical Society, are at last ready for issue by Mr. Stanford.

Dr. Harmand, who has for some time been an assistant secretary of the French Geographical Society, and has lately been appointed Consul for France at Bangkok, is shortly to avail himself of the opportunity thus offered for making natural history and ethnographical collections in the Indo-Chinese peninsula.

We have received parts 27–29 of the new edition of Stieler's Hand Atlas, containing the following maps:—A railway and steamer map of Germany and neighbouring countries; Austria-Hungary; India and Inner Asia, northern sheet; a meteorological chart of the world; Iran and Turan; general map of South America; sheet 4 of the six-sheet map of South America; North-East Africa and America; South Africa and Madagascar. Other three parts, containing eight maps, will conclude the new issue of this Standard Atlas, which will have ninety-five maps in all.

The *Deutsche Geographische Blätter* (Heft 4 Band 10) of the Bremen Society contains the narrative of the brothers Krause, sent by the Society to explore the Behring Straits region, mainly for commercial purposes. Capt. Koldeway contributes a paper on the position of the Arctic ice during the past summer, which was peculiar in some respects; Capt. Koldeway shows that it was dependent on meteorological conditions with which we are imperfectly acquainted, but for a knowledge of which the Arctic observing stations ought to do much. There is also a useful summary of the Arctic work of the year, in which it is claimed for Capt. Dallmann that he was the first to land on Wrangel Land in 1866. In a note on p. 448 of the "Voyage of the *Vega*," vol. i., Baron Nordenskjöld, however, thinks it strange that Dallmann should only now have mentioned this voyage.

Since 1873, Herr Dietrich Reimer of Berlin has published at intervals important contributions to the literature of African exploration, under the title of "Beiträge zur Entdeckungsgeschichte Afrika's." The first issue was a series of small maps showing the progress of a general knowledge of Africa from antiquity down to the nineteenth century. The second contains a paper on the part taken by Germany in African exploration, and a map, with text, showing what the various nationalities have done for African exploration during the nineteenth century. The third issue is a volume containing the journal of Dr. Paul Pogge during his exploration of the Lunda States, in the southern basin of the Congo in 1875-6. The fourth volume gives a narrative of Herr Otto H. Schütt's exploration on the Lower Quanza in 1877-9. These are all of considerable value, especially the two last issues, which contain the results of much detailed work by competent scientific observers. We trust Herr Reimer will be encouraged to continue his enterprise.

The Vienna Geographical Society celebrated the twenty-fifth anniversary of its foundation on December 22 last. The Society numbers 74 honorary and 644 ordinary Members; its library consists of nearly 11,000 works.

The geographical weekly *Das Ausland* has changed hands. Up to December 31 last its editor was the well-known geographer, Fr. von Hellwald; his place is now taken by Prof. Friedr. Ratzel of Munich. The paper will in future confine its contents solely to geographical and ethnographical subjects.

ACTION OF FREE MOLECULES ON RADIANT HEAT, AND ITS CONVERSION THEREBY INTO SOUND[1]

The lecture opens with a brief reference to the researches of Leslie, Rumford, and Melloni. The labours of Tyndall and Magnus, as far as they bear upon the present subject, are then succinctly sketched, their points of difference being

[1] Abstract of the Bakerian Lecture, by J. Tyndall, F.R.S., given at the Royal Society, November 24, 1881.

signalised and briefly discussed. This preliminary sketch is wound up by a reference to a recently published paper by Lecher and Pernter, who, while supporting the lecturer in the matter of gases, dissent from him in the matter of vapours. These investigators are especially emphatic in affirming the neutrality of aqueous vapour to radiant heat. Following Magnus, they refer Tyndall's results to what Magnus calls "vapour-hesion," that is to say, to the condensation of the vapours on the surfaces of the plates of rock-salt used to close the experimental tube, and on the interior surface of the tube itself.

In November, 1880, the lecturer's investigations in this field were resumed. Former experiments were repeated and verified with divers sources of heat, and with various experimental tubes—some polished within, and others coated inside with lampblack. The results obtained with the one class of tubes are substantially the same as those obtained with the other.

But even a coating of lampblack may be supposed to reflect a certain amount of heat, hence the desirability of an arrangement whereby internal reflection should be entirely abolished. This was accomplished in the following manner:—A spiral of platinum wire, rendered incandescent by a voltaic current of measured strength, was chosen as source of heat. An experimental tube 38 inches long and 6 inches in diameter had two circular apertures at its ends, closed by transparent plates of rock-salt, 3 inches in diameter. The tube was furnished with three cocks—one connected with a large Bianchi's air-pump; another with a purifying apparatus; while through the third vapours and gases could be admitted. Prior to entering the tube the calorific rays were sent through a very perfect rock-salt lens, by means of which an image of the spiral was formed on the most distant plate of rock-salt. To obtain the image with clearness, the spiral was first rendered highly luminous, and afterwards reduced, by the introduction of resistance, to the required temperature. In this way a calorific beam was sent along the axis of the experimental tube without at all impinging upon its interior surface. No reflection came into play; no absorption by hypothetical liquid films, coating the internal surface, could occur; and yet experiments made with this arrangement entirely confirmed the preceding ones, wherein by far the greater quantity of heat which reached the pile had undergone reflection.

When the source of heat was changed to a carefully-worked cylinder of lime, a portion of which was rendered incandescent by an ignited stream of coal-gas and oxygen, the results were confirmatory of those obtained with the spiral. The order of absorption in both cases was the same, the only difference being that the fractional part of the total radiation absorbed in the case of the lime-light was less than that absorbed in the case of the spiral.

To condense the radiation from the lime-light, concave mirrors were sometimes employed, and sometimes rock-salt lenses. The results in both cases were identical.

An experimental tube of the dimensions here given was employed by the lecturer to check his results more than ten years ago. Its interior surface was rough and tarnished, and when warmed dynamically by the entrance of a gas its power as a radiator enabled it to disturb, to some slight extent, the purity of the results. To obviate this, the experimental tube recently employed was provided with an internal silver surface, deposited electrolytically and highly polished. By this arrangement the radiation of the tube itself, as well as its absorption, was rendered quite insensible.

The rock-salt plates used to close the experimental tube, and on which liquid films are alleged to be deposited, remain to be examined. In this case also an *experimentum crucis* is possible. If the observed absorptions be due to such liquid films, then the separation of the salts more widely from each other, the space between them being copiously supplied with vapour, ought to produce no effect; but if the absorption, as alleged by the lecturer, be the act of the vapour molecules, then the deepening of the absorbing stratum ought to produce an augmented effect. For many gases and some vapours this problem was solved as far back as 1863. By means of an apparatus then described, polished plates of rock-salt could be brought into contact with each other, and then gradually separated, until the gaseous stratum between them was some inches in depth. With sulphuric ether vapour, the distance between the plates being one-twentieth of an inch, an absorption of 2 per cent. was observed. With a thinner stratum, or a weaker vapour, even this small absorption vanished, while in passing from one-twentieth of an inch to two inches the absorption rose from 2 per cent. to 35 per cent. of the total radiation. Such experiments, recently verified, entirely dispose of the hypothesis that liquid films were the cause of the observed absorption.

The "vapour-hesion hypothesis" involves the assumption that liquids exert on radiant heat an absorbent power which is denied to their vapours. It assumes, in other words, that the seat of absorption is the molecule considered as a whole, and not the constituent atoms of the molecule. For were the absorption intra-molecular, the passage from the liquid to the vaporous condition, which leaves the molecules intact, could not abolish the absorption. So far back as 1864 the lecturer had proved that when vapours, in quantities proportional to the densities of their liquids, were examined in the experimental tube, the order of their absorptions was precisely that of the liquids from which they were derived. This result has been recently tested and verified in the most ample manner by means of the apparatus in which internal reflection never comes into play. It furnishes, therefore, the strongest presumptive evidence that the seat of absorption in liquids and in vapours is the same.

As a problem of molecular physics it was, however, in the highest degree desirable to compare together *equal* quantities, instead of proportional quantities, of liquids and vapours. Highly volatile liquids alone lend themselves to this experiment, for only from such liquids can vapours be obtained sufficient, when caused to assume the liquid form, to produce layers of practicable thickness. Two cases, however, have been very fully worked out, the substances employed being the hydride of amyl and sulphuric ether. Careful and exact experiments, many times repeated, lead to the result that when the number of molecules traversed by the calorific rays in the vapour is the same as that traversed in the liquid, the absorptions are identical. In the silvered experimental tube, which, as stated, is 38 inches long, hydride of amyl vapour, at a mercury pressure of 6·6 inches, is equivalent to a liquid layer 1 millim. in thickness, while a vapour column of sulphuric ether, of the same length, and 7·2 inches pressure, would also produce a liquid layer 1 millim. thick. The experiment has been made with the utmost care, both with the lime-light and the incandescent platinum, with the result that it is impossible to say that there is any difference between the vapour absorption and the liquid absorption. In the face of such facts the "vapour-hesion" hypothesis, as an explanation of the results published by the lecturer, cannot be sustained.

On November 29, 1880, he had the pleasure of witnessing, in the laboratory of the Royal Institution, the experiments of Mr. Graham Bell, wherein a concentrated luminous beam, rendered intermittent by a rotating perforated disk, was caused to impinge upon various solid substances, and to produce musical sounds. Mr. Bell's previous experiments upon selenium naturally led him to conclude that the effect was produced by the luminous rays of the spectrum. The contemplation of these experiments produced in the lecturer the conviction that the results were due to the intermittent absorption of radiant heat. He was experimenting on vapours at this time. Substituting in idea gaseous for solid matter, he clearly pictured the sudden expansion of an absorbent gas or vapour at every stroke of the calorific beam, and its contraction when the beam was intercepted. Pulses far stronger than those obtainable from solid matter would probably be thus produced, which, when rapid enough, would generate musical sounds. The intensity of the sound would, of course, be determined by the absorptive power of the gas or vapour.

This idea was tested on the spot. Placing sulphuric ether in a test-tube, and connecting the tube with the ear, the intermittent beam was caused to fall upon the vapour above the liquid. A feeble musical sound was distinctly heard. Formic ether was tried in the same way, and with the same result. Bisulphide of carbon was then tried, but the vapour of this liquid proved incompetent to generate a musical sound. These results, which were in perfect accordance with those previously enunciated by the lecturer, were first made public during a discussion at the Society of Telegraph Engineers on December 8, 1880 (*Journal of Telegraph Engineers*, vol. ix. p. 382).

It was obvious, however, that the arrangement of Mr. Bell—a truly beautiful one—was not suited to bring out the maximum effect. He had employed a series of lenses to concentrate his beam, and these, however pure, would, in the case of transparent gases, absorb a large portion of the rays most influential in producing the sound. The lecturer, therefore, resorted to lenses of rock-salt and to concave mirrors silvered in front. He

employed various sources of heat, including that of the electric lamp. The lime-light he found very convenient. With the lime-light and concave mirror, sounds of surprising intensity were produced by all the highly absorbent gases and vapours. Among gases chloride of methyl was loudest. Conveyed directly to the ear by a tube of india-rubber, the sound of this gas seemed as loud as the peal of an organ. Abandoning the ear-tube, and choosing a suitable recipient for the gas, the sounds were heard at a distance of 20 feet from their origin. As regards intensity, the order of the sounds, in gases, corresponds exactly with the order of their absorptions of radiant heat.

Among vapours sulphuric ether stands highest, this result being in part due to the great volatility of the liquid. But the intensity of the sound is by no means wholly dependent on volatility. The specific action of the molecules on radiant heat is as clearly shown in these experiments as in those previously conducted with the experimental tube and thermopile. Upwards of eighty vapours have been tested in regard to their sound-producing power.

With regard to aqueous vapour, whose action upon radiant heat even the latest publications on this subject describe as *nil*, it was especially interesting to be able to question the vapour itself as to its absorbent power, and to receive from it an answer which did not admit of doubt. A number of bulbs about an inch in diameter were placed under the receiver of an air pump, with a vessel containing sulphuric acid beside them. When thoroughly dry they were exposed to an intermittent beam. The well-dried air within the bulbs proved silent, while the slightest admixture of humid air sufficed to endow it with sounding power. Placing a little water in a thin glass bulb, and heating it nearly to its boiling point, the sounds produced by the developed vapour are exceedingly loud. The bulbs employed in these experiments are usually about a cubic inch in volume. They may, however, be reduced to one-fiftieth or even one one-hundredth of a cubic inch. When a minute drop of water is vaporised within such little bulbs, on their exposure to the intermittent beam loud musical sounds are produced.

It is to be borne in mind that the heat employed in these experiments, coming as it did from a highly luminous source, was absorbed in a far smaller degree than would be the heat from bodies under the temperature of incandescence.

To render the correlation of sound-producing power and adiathermancy complete, all the gases and vapours which had been exposed to the intermittent beam were examined as to the augmentation of their elastic force through the absorption of radiant heat. A glass cylinder, 4 inches long and 3 inches in diameter, had its ends closed with transparent plates of rock-salt. Connected with this cylinder was a narrow U-tube, containing a coloured liquid which stood at the same level in the two arms of the U. The cylinder could be exhausted at pleasure or filled with a gas or vapour. When filled, the sudden removal of a double-silvered screen permitted the beam from the lime-light to pass through it, the augmentation of elastic force being immediately declared by the depression of the liquid in one of the arms of the U-tube and its elevation in the other. The difference of level in the two arms gave, in terms of water-pressure, a measure of the heat absorbed. With the stronger vapours it would be easy with this instrument to produce an augmentation of elastic force corresponding to a water-pressure of a thousand millimetres. As might be expected the intensity of the sounds corresponded with the energy of the absorption, varying from "exceedingly strong," "very strong," "strong," "moderate," "weak," to "inaudible." In this connection reference was made to the interesting experiments of Prof. Röntgen, an independent and successful worker in this field.

In conclusion, the lecture draws attention to the bearing of its results upon the phenomena of meteorology. The views of Magnus regarding the part played by mist or haze, are referred to and attention is directed to various observations by Wells which are in opposition to these views. The observations of Wilson, Six, Leslie, Denham, Hooker, Livingstone, Mitchell, Strachey, and others are referred to and connected with the action of aqueous vapour upon solar and terrestrial radiation. Many years ago the lecturer sought to imitate the action of aqueous vapour on the solar rays by sending a beam from the electric light through a layer of water, and afterwards examining its spectrum. The curve representing the distribution of heat resembled that obtained from the spectrum of the sun, the invisible calorific radiation being reduced by the water from nearly eight times to about twice the visible. Could we get above the screen of atmospheric vapour, a large amount of the ultra-red rays would assuredly be restored to the solar spectrum. This conclusion has been recently established on the grandest scale by Prof. Langley, who on September 10 wrote to the lecturer from an elevation of 12,000 feet on Mount Whitney, "where the air is perhaps drier than at any other equal altitude ever used for scientific investigation." An extract from Prof. Langley's letter will fitly close this summary :—"You may," he says, "be interested in knowing that the result indicates a great difference in the *distribution* of the solar energy here from that to which we are accustomed in regions of ordinary humidity, and that while the evidence of the effect of water-vapour on the more refrangible rays is feeble, there is, on the other hand, a systematic effect due to its absence, which shows, by contrast, its power on the red and ultra-red in a striking light. These experiments also indicate an enormous extension of the ultra-red rays beyond the point to which they have been followed below, and being made on a scale different from that of the laboratory—on one indeed as grand as nature can furnish—and by means wholly independent of those usually applied to the research, must, I think, when published, put an end to any doubt as to the accuracy of the statements so long since made by you, as to the absorbent power of water-vapour over the greater part of the spectrum, and as to its predominant importance in modifying to us the solar energy."

SOCIETIES AND ACADEMIES

London

Royal Society, December 8.—"On the Electrolytic Diffusion of Liquids," by G. Gore, LL.D., F.R.S. In this communication the author has described an apparatus, and an attempt made with it, to ascertain more definitely than he was able in a previous research (on "the Influence of Voltaic Currents on the Diffusion of Liquids," *Proc.* Roy. Soc., No. 213, 1881) whether, when an electric current is passed vertically through the boundary surface of mutual contact of two electrolytes lying upon each other in a narrow vertical glass tube, the mass of either of the liquids expands or moves as a whole in the line of the current, and also to obtain additional data to assist in explaining the phenomena observed in the previous research.

The results obtained with a solution of mercuric nitrate (sp. gr. 1·30) below, and a solution of cupric nitrate (sp. gr. 1·22) above, showed, first, and most conclusively, that the upper liquid diffused downwards continuously through the meniscus in the glass tube (the meniscus remaining motionless) during the passage of an upward electric current; and second, that either no manifest expansion occurred in the liquid next the cathode in the upper solution, and that equal volumes of liquid diffused in two opposite directions through the meniscus; or that any expansion of the upper liquid was compensated for by downward diffusion of an equal bulk of that liquid. Another possibility was that the united volumes of metallic-electro deposited copper, and of the acid element from which it had been separated by electrolysis, were greater than before such separation, and that this was exactly compensated by the volume of liquid diffused downwards through the meniscus.

Zoological Society, December 13.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. Sclater exhibited and made remarks on two skins of a Rail from Macquarie Island, south of New Zealand, which had been sent to him by Sir George Grey, K.C.B.—Mr. H. Seebohm exhibited and made remarks on specimens of the Rusty Grakle (*Scolecophagus ferrugineus*) and Pallas's Great Grey Shrike (*Lanius major*), which had been shot near Cardiff, and were new to the British avifauna.—A communication was read from Mr. Clements R. Markham, F.R.S., containing an account of his researches into the former whale-fishery of the Basque Provinces of Spain.—Messrs. J. J. Lister and J. J. Fletcher read a paper on the condition of the median portion of the vaginal apparatus in the Macropodidæ, in which they arrived at the following conclusions :—(1) In the Macropodidæ the median vaginal canal is closed in early life. (2) In the genera *Macropus*, *Halmaturus*, and *Petrogale* (and perhaps also *Dorcopsis* and *Dendrolagus*) an opening is formed, leading directly from the median vaginal canal into the urogenital sinus, which opening most probably gives passage to the young. This opening may be formed early in life, as is usual in the genus *Halmaturus*, or not till young are about to be

produced, as in *Macropus rufus*. (3) The evidence with regard to *Macropus major* is conflicting; in one case the median canal has been found open after parturition, and in two others closed. (4) In *Hypsiprymnus gaimardi* (and probably also *H. murinus*) the median canal remains closed, and the young passes down the lateral vaginal canals, which present a different structure from that found in the other examples of Macropodidæ.—A communication was read from the Rev. Canon Tristram, containing the description of a new Fruit-Pigeon of the genus *Carpophaga*, from the Louisiade Archipelago, which he proposed to name *Carpophaga salvadorii*.

Geological Society, December 7.—Mr. R. Etheridge, F.R.S., president, in the chair.—William Amherst Tyssen Amherst, M.P., Robert Edward Cresswell, W. R. Eaton Hodgkinson, Simon D. Macdonald, Rev. Edward Cook Pritchard, Rev. Alexander Simpson, B.Sc., Prof. William Waagen, Ph.D., Frederick John Webb, and Charles Henry Wilson, were elected Fellows of the Society.—Mr. W. Topley made a statement respecting the International Geological Congress at Bologna.—Prof. Judd, at the request of Prof. John Milne, of the Imperial Engineering College of Tokio, Japan, called the attention of the Members of the Society to the important work now being carried on by the Seismological Society of Japan. Geologists could become Members of the Seismological Society of Japan (which stands greatly in need of help) by an annual payment of 1*l.*, which will entitle them to receive the whole of the publications of the Society. Prof. Judd was prepared to receive the names of Members on behalf of Prof. Milne.—The following communications were read:—The zones of the Blackdown beds and their correlation with those at Haldon, with a list of the fossils, by the Rev. W. Downes, B.A., F.G.S.—On some new or little-known Jurassic Crinoids, by P. Herbert Carpenter, M.A. Communicated by Prof. P. Martin Duncan, M.B. Lond., F.R.S., F.G.S.—Notes on the Polyzoa of the Wenlock shales, Wenlock limestone and shales, over the Wenlock limestone. From material supplied by G. Maw, F.L.S., F.G.S. By G. R. Vine. Communicated by Dr. H. C. Sorby, F.R.S., V.P.G.S.

Anthropological Institute, December 13, 1881.—Mr. Hyde Clarke, vice-president, in the chair.—The election of Mrs. C. Hancock was announced.—The discussion on the Rev. R. H. Codrington's paper on the affinity of the Melanesian, Malay, and Polynesian languages was continued by Mr. A. H. Keane and Mr. Hyde Clarke.—Mr. M. J. Walhouse read a paper on some vestiges of girl-sacrifices, jar-burial, and contracted interments in India and the East. The great megalithic forms of interment, consisting of Kistvaens, or sepulchral underground chambers, formed of four huge slabs, covered with an immense capstone, and surrounded by a circle of standing stones, abound in nearly all the provinces of the Madras Presidency; but beside these there is another description of burial peculiar to the region of the western coast from Malabar to Cape Comorin. This consists of huge mortuary jars or urns, pear shaped, usually about five feet high by four feet in girth round the shoulders, and tapering to a point at bottom. They are of coarse, thick, red ware, wide-mouthed, generally with a rude incised cross-pattern round their neck. These great urns are buried upright in the ground, not in any cist or chamber, and a large flat stone or slab is laid over them, but no circle of stones ever placed around. They are filled with earth, and contain at the bottom a quantity of bones broken small, some pieces of iron, and occasionally a small urn also filled with bits of bone; or sometimes with clean sand, red or white, which must have been brought from a distance.—Mr. G. Bertin read a paper on the origin and primitive home of the Semites, which was followed by a discussion.

Entomological Society, December 7.—Mr. H. T. Stainton, President, F.R.S., in the chair.—Mr. A. J. Scollick was elected a Member.—Exhibitions: A variety of *Ennomos tiliaria*, Borkh., by Mr. W. E. Boyd.—Bred specimens of *Scenopinus fenestralis*, Latr., *Phora rufipes*, Meig., and *Oscinis pusilla*, Latr., by Mr. C. O. Waterhouse.—A larva of an undetermined species of ant-lion, from Zante, by Mr. F. P. Pascoe. A Curculionideous larva, found feeding in the bulbs of lilies, probably from Japan, by Mr. R. McLachlan.—A specimen of *Harpalus cupreus*, Dej., from the Isle of Wight, by Mr. A. S. Olliff.—A supposed new species of *Telephorus*, from West Wickham, by Mr. H. B. Pim.—Communications: a box of locust egg-cases, with specimens of the Bombyliid larva found feeding on the eggs, transmitted by Sir Robert Biddulph from Cyprus, was exhibited by the Secretary, who read a communication received therewith from the Colonial Office, and the report of the Committee appointed by the Society to investigate the subject.—Sir S. S. Saunders read some remarks received from M. E. André, relative to a species of *Scleroderma*.—Mr. C. O. Waterhouse read remarks on the types of *Cynips psenes* and *C. sycomori*, in the Linnean collection.—Mr. W. L. Distant read descriptions of new species belonging to the Homopterous family *Cicadidæ*; and Mr. A. G. Butler communicated a list of heterocerous *Lepidoptera* collected in Chili by Mr. T. Edwards; Part i., Sphinges and Bombyces.

VIENNA

Imperial Academy of Sciences, December 9, 1881.—V Burg in the chair.—The following papers were read:—Ed. Neusser, a contribution to the knowledge of the colouring-matters of urine.—Bohuslav Branner (Manchester), contribution to the knowledge of cerium metals.—N. v. Lorenz, on the action of metallic lead on an aqueous solution of nitrate of lead.—Willibald Vinier, a sealed packet without inscription.—G. Tschermak, on a previously unobserved case of hemhedry of fesseral system.—E. Weiss and T. Palisa, computation of the elements and ephemeris of the comets probably discovered by Mr. Wendell of Harvard College at Cambridge (Mass.).—W. Tinter, on the error made on putting the cross-wires into the plane of image.

December 15, 1881.—L. T. Fitzinger in the chair.—The following papers were read.—L. Boltzmann, on the theory of the viscosity of gases (part 3).—Some experiments made on the impact of cylinders, by the same.—Fr. Brauer, on the Diptera of the Imperial Museum at Vienna.—A. v. Heider, on the genus *Cladocera*, Ehrenberg.—T. Gaunersdorfer, contributions [to a knowledge of the nature of the *heart-wood*.—O. Tumlirz, on the flow of an incompressiole liquid through pipes of circular section and of any one shape and situation.—On the rotatory movement of a homogeneous liquid around an axis by influence of friction, by the same.—Bela Haller, on the anatomy of the nervous system of the *Muricida*.—T. V. Rohon, researches on *Amphioxus lanceolatus*.—F. Lorenz, on the skeletons of *Stringops habroptilus* and *Nestor notabilis*.—L. v. Barth and M. Kretschy, on the *Pirotoxin* question.—Sig. Freud, on the structure of nerve-cells of the crayfish.—T. Liznar, on the results of magnetic measurements made in Moravia and Silesia.

PARIS

Academy of Sciences, December 12, 1881.—M. Daubrée in the chair.—The following papers were read:—Surveys and itineraries executed in Tunis, by M. Verrier.—Experiments on the rapidity of absorption of virus at the surface of wounds, by M. Davaine. Small portions of the skin of rabbits were cut out with scissors, and fresh virulent anthracic blood was spread on the wound. After one hour or more, the wound was deeply cauterised. Two-thirds of the animals were preserved (a result quite different from those of Renault and M. Colin, who inoculated animals after making a small sub-epidermic incision, and found cauterisation unavailing. An explanation is offered).—On groups of binary forms having the same Jacobian, by M. Stephanos.—Researches with a view to discover organisms parasitic on phylloxera, by M. Gayon. He found microscopic organisms in a small percentage of phylloxeras examined, and tried to cultivate them. Chicken-broth neutralised with potash, and having a phylloxera (first scorched in flame), or some liquid from its body, put into it, soon swarmed with agile rods (bacteria or vibrions), but the author is not sure that the alterative germs were always from the insects (the development being constant). A curious green crystal-yielding product of those microbes, is noted. M. Gayon, is pursuing his studies.—On equations of the form $\Sigma \int_a^b e^{-zx} F(z)dx = 0$, by M. Laguerre.—On a series of Abel, by M. Halphen.—Remarks on the introduction of continuous functions not having a derivative, into the elements of mechanics, by MM. Appell and Jannand.—On a class of functions analogous to Θ functions, by Mr. Elliott.—On international polar expeditions, by M. Mascart. The object is to study, not the formation and course of cyclones, but terrestrial magnetism and allied phenomena; and in this respect the importance of polar stations is indubitable.—On the methods of comparison of induction coefficients, by M. Brillouin.—On the specific heats of gases at high temperatures, by MM. Mallard and Le Chatellier. They find the mean specific heat of carbonic acid, at constant volume, between 1800° and 0° (referred to the equivalent 44), to be represented by 12·6. It increases

continuously up to 2000°, but the rate of increase diminishes with removal from 0°. The formula gives a maximum of 13·7 at 2160°. The specific heats of hydrogen, nitrogen, oxygen, and carbonic oxide, which are equal at 0°, are still so at temperatures exceeding 2000°. The mean specific heat of aqueous vapour, referred to the equivalent 18, is about 11·5 at 1600°.—On the solubility of sulphate of baryta and strontium in concentrated sulphuric acid, by MM. Narenne and Pauleau.—Processes of direct coppering of cast-iron, iron, and steel, by M. Weil. Three are described. The injurious and dear cyanides are replaced by organic acids, or by glycerine.—Pocket-battery with articulated elements, by M. Pulvermacher.—On the decomposition of water by electric effluves in presence of nitrogen, by MM. Deherain and Maquenne. The effluve of high tension causes direct combination of the nitrogen with the elements of the water, producing nitrite of ammonia. This effluve was also proved capable (like that of weak tension) of causing fixation of nitrogen in organic matters.—On the decomposition of metallic formiates in presence of water; production of some crystalline mineral species, by M. Riban.—On the influence of the choroid on acuteness of vision, by M. Fano. He describes observations of the vision of persons having choroidian atrophy.—On tetronerythrine in the animal kingdom, and its physiological *rôle*, by M. de Merejkowski.—On the origin of spermatozoids in hydrozoa, by M. de Varenne.—Note on some points still obscure in the organisation and development of Echinorhynchi, by M. Mégnin. The presence of a bifurcating intestine brings these Helminths towards Trematodes, and removes them from Nematoids.—On the characters presented by speech in deaf-mutes who have learned to articulate sounds, by Prof. Bell.—Observations on the last eruption of Mauna Loa, from November, 1880, to August, 1881, by Mr. Green. He sends and discusses a series of photographs of the lava current, which is the most remarkable that has occurred within fifty years.

December 26, 1881.—M. Wurtz in the chair.—M. Favre presented a fourth and last batch of M. Chasles' scientific MSS. (the total numbering 113).—On some applications of the theory of elliptic functions, by M. Hermite.—Note on the mode of action of soluble ferments, by M. Wurtz. Pepsine and papaine being fixed, in the insoluble state, on certain albuminoid matters, so modify these that they can be hydrated at 40° by action of pure water, forming true peptones.—Classification of fractures of different orders (lithoclases), presented by the earth's crust, by M. Daubrée. Lithoclases are divisible into—I. Leptoclases: small fractures in two directions or one, and either synclases (*interior* mechanical action) or piesoclases (*exterior*); II. Diaclases: fractures often extending, with nearly plane form, more than 100 m. in horizontal or vertical direction. III. Paraclases: like diaclases, but often exceeding 1000 m. in horizontal direction, and presenting great outthrow of indefinite depth. Examples are given in a synoptical table.—Is the ramification in plants everywhere and always acropetal? by M. Trécul. He is led to a negative.—Reply to M. Daubrée's observations in the *séance* of December 19, by M. Blanchard. M. Blanchard had not questioned the existence of an interior sea in the tertiary epoch, about the end of which he had supposed it to disappear, through elevation. Mere isthmuses would have been insufficient for the dissemination which occurred.—Observations on the state of the Mediterranean at the close of the tertiary epoch, by M. Hébert. He gives evidence of an emersion, more or less, at the end of the miocene, and at the end of the pliocene In pliocene time (he thinks) the bottom had not the great inequalities observed now, these being due to dislocations in the quaternary epoch. On the successive differences of observations, by M. Bréger.—M. Malligand indicated the service rendered by his ebullioscope (for determination of alcohol in wines), which the French Syndical Chambers adopted in 1878.—Elements and ephemerides of the comet *g* 1881 (Swift), by M. Bigourdan.—On the successive differentials of functions of several independent variables, by M. Darboux.—On some examples of reduction of Abelian integrals to elliptic integrals, by M. Picard.—Note on naval tactics calculated by Lieutenants Des Portes and Aubert, under direction of Capt. Trève, by M. Trève.—On the works of the Swiss Seismological Commission, and on earthquakes recently experienced in Savoie, by M. Soret. A peculiar feature of some earthquakes, originating south-east of the Lake of Geneva, is that they had a strong effect on the north side of the lake, but were hardly felt on the south side, though this was nearer the place of origin.—On the function which expresses the gaseous state, and on the function λ, such that $\frac{dQ}{\lambda}$ is an exact differential, by M. Gouilly.—Contractions and dilatations produced by electric tensions in hemihedral crystals with inclined faces, by MM. Jacques and Pierre Curie. Between two bronze plates were secured two systems, the lower (to measure variations of pressure) formed of three large thin quartz plates separated by metallic plates, which were connected with an electrometer; the higher, of three large hemihedral crystals, separated by two copper rundles, on one of which were applied two bases positive by pressure, on the other two negative bases The two exterior bases communicated with earth; the two copper rundles with a Holtz machine. The dilatation of the upper system compressed the lower, and the electrometer was affected. The phenomenon was of the same order of magnitude as theory indicated.—On the decomposition of some metallic acetates in presence of water; production of crystalline mineral species, by M. Riban.—Influence of heat and proportions of glycerine on the decomposition of oxalic acid, by Mr. Lorin. The etherification of formic and oxalic acids is, in this class of experiments, a secondary accident.—On essence of angelica, by M. Naudin.—Method of purifying arsenious coppers, by M. Garnier.—Experimental researches proving that various causes, but especially lesions of the brain, may produce, after death, a general or local contraction, by M. Brown-Séquard.—On the mechanism of motor-troubles produced by excitations or lesions of the circumvolutions of the brain, by M. Conty. The circumvolutions do not seem to have any direct relation to the muscles; it is the spinal cord that plays the predominant *rôle* of centre of reaction and transformation.—On the excretion of uric acid in birds, by M. Cazeneuve. Experimenting with sparrow-hawks, he proved that the stimulation or diminution of combustion does not alter the ratio of the principles excreted. The totality of elements increases or diminishes with the quantity of food ingested; which depends on the stimulant or depressive conditions of the medium.—On the *Gastornis Edwardsii* and the *Remiornis Heberti* of the Lower Eocene of the environs of Rheims, by M. Lemoine.—Do the inferior Crustaceans distinguish colours? by M. de Merejowsky. They distinguish quantity, but not quality, of light.—Prolongation of the vegetative activity of chlorophyllian cells under the influence of a parasite, by M. Cornu. He mentions several cases of analogy to the state of lichens (which have vigorous life, though now understood to consist of an alga and a parasitic champignon).—On Sphenozamites, by M. Renault.—On the supposed organisms of meteorites, by M. Vogt. He controverts this theory of M. Hahn, and argues that the structures are inorganic.

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THURSDAY, JANUARY 12, 1882

CLERK MAXWELL'S "ELECTRICITY AND MAGNETISM"

A Treatise on Electricity and Magnetism. By James Clerk Maxwell. Second Edition. (Oxford: At the Clarendon Press, 1881.)

An Elementary Treatise on Electricity. By James Clerk Maxwell. Edited by William Garnett, M.A. (Oxford: At the Clarendon Press, 1881.)

THESE volumes have a melancholy interest for the student of electrical science, inasmuch as they are the unfinished work of one of its great masters. The printing of the second edition of the larger work had reached the second half of the first volume when it was interrupted by the premature death of the author. Up to this point considerable modifications have been introduced into the work; but the rest is merely a reprint under the superintendence of Mr. W. D. Niven, of Trinity College, Cambridge.

We shall allude by and by to these alterations in the earlier part of the new edition; but it may not be without interest to the readers of NATURE briefly to review the progress of electrical science during the eight years that have elapsed since the publication of the first edition, and to trace the influence of the work therein.

Clerk Maxwell appeared avowedly as the mathematical expositor of Faraday; in this he was the pupil and follower of Sir William Thomson. The electrical papers of the last, reprinted the year before Maxwell's work appeared, reach some of them as far back as 1842; and in the earliest of them he occupies himself with the translation of Faraday's ideas into the ordinary language of Mathematical Physics. He shows that his translation leads to a theory in no wise contradictory of the received theory of action at a distance, so far at least as this theory merely exhibits the facts of observation; but to a theory in some respects more comprehensive, inasmuch as certain experimental facts find a much more natural explanation in it than in the older and more prevalent one. It may be asserted, without fear of contradiction, that Sir William Thomson was the first who thoroughly understood and clearly expounded Faraday. Abroad his methods and conceptions were decried as vague and, although suggestive and worthy of notice, as the machinery that had been used by a man of genius, yet devoid of accurate foundation.[1] At home the loose way in which Faraday's methods and terms had been used, or more properly speaking, abused by many, gave but too specious a confirmation of the justice of this criticism.

What Thomson began Maxwell continued, and in a sense completed. In his work we have the first systematic exposition of Faraday's theory of a dielectric medium applied to all the main phenomena of electricity.

He shows, for the first time, that all the ordinary phenomena of electrical action and reaction can be explained by the thoroughly legitimate physical hypothesis of *stresses* in the medium of having a static or a kinetic origin, as the case may be.

Had this innovation been a mere matter of the transformation of surface into volume integrals (as may still seem perhaps to some who are mathematicians by birth, and physicists by application only), it would not be necessary to dwell on it in these pages. But it was far more. To the old theory of action at a distance, in so far as it assigned the mathematical laws of certain of the observed facts, there could be no sort of objection. Its success in this respect is scarcely rivalled by that of the corresponding artifice in celestial dynamics.

But the theory of action at a distance was not, and never could be, a dynamical explanation of electrical phenomena. It may be true that we know little of what occurs in the medium between electrified conductors; but we are not likely to extend our knowledge by adopting a theory which begins by directing us to divert our attention altogether from the very field in which a dynamical explanation *must* be sought. This strong argument against it is supported by the still stronger, that, notwithstanding the admirable accuracy with which the old theory explains a large body of facts, there are still other facts, continually increasing in number, of which it gives no explanation whatever, if indeed they do not flatly contradict it.

The medium theory was therefore a first and necessary step towards a dynamical theory of electricity. It begins by divesting the facts of all hypothetical raiment, and expressing them in language appropriate to themselves, suggesting nothing but what Nature has indicated, indicating nothing that Nature has denied, supposing as little as may be where nothing has been revealed. Above all banishing from the catalogue of physical conceptions the imponderable electrical fluids that have worked such mischief in indolent minds, and poisoned electrical literature so long.

Moreover the old theory, although it was a weapon of wonderful power in the hands of expert mathematicians, was difficult of translation into even technical verbal expression. It was inflexible and unwieldy when applied in general explanation, and in the universally occurring cases where approximate estimation is all that is necessary or desirable. In one sense therefore Maxwell's treatise was a popularisation of the theory of electricity. By this we do not mean that Faraday's method of lines of force brings the subject to the level of a mind untrained in the handling of accurate ideas, but simply that it often renders the profound and laboriously acquired skill of the mathematical expert unnecessary. In the highest sense, viz. that of an accurate thinker, Faraday himself was, as has been often said, a great mathematician; although he was so little of a mathematical expert, that he once expresses his obligation to one who had calculated the tangents of some galvanometer deflections for him. And yet complaints have often been made of the obscurity of Clerk Maxwell's work. Certainly it is not easy reading; but the difficulties are always to be found where Nature has herself set them; they arise simply because the author refuses to put a bridge over the gap presented by experience. Such complaints come alike from the mathematician in search of an ideal logical completeness, and ever impatient of *facts* that do not fit with his preconception; and from

[1] If the reader wishes to see how much Maxwell's work has done to popularise Faraday's ideas abroad let him consult the electrical papers that have appeared of recent years in *Wiedemann's Annalen*, or read the emphatic testimony of Helmholtz, given at the commencement of the Faraday lecture. See Jour. Chem. Soc., June, 1881.

those whose powers of generalisation do not carry them far enough to put them above regarding the small details of experiment as the ultimate end of science. For both classes there are lessons in Maxwell's pages.

Another most important feature of the work under review is that it is in the strictest sense a Treatise on Electrical *Measurement*. It looks at electrical actions almost exclusively as measurable; it does not profess to be a complete experimental treatise of all electrical phenomena qualitatively or quantitatively observed. In this respect it is a continuation of the labours of its author in conjunction with the rest of the distinguished band of electricians who formed the Committee of the British Association on Electrical Measurements. Maxwell's work is in many parts, particularly in the second volume, a development of the methods employed by this Committee. Many of the electrical measurements there described had, when the volumes were first published, been actually carried out only by the author himself or by very few beside; but now the great majority of them have become the commonplaces of a physical laboratory.

The effect on practice of the work thus consummated in Maxwell's Treatise has been, both directly and indirectly, enormous. The extension of technical applications has been immensely facilitated by the introduction of definite units. Instead of the old vague, unscientific, and still more, unbusinesslike statements of quantity and intensity, we have the precise ideas of electromotive force, resistance, current, and so on, measured in their respective units, the volt, the ohm, the ampère, &c.; and now electrical commodities can be bought and sold by rule and measure, as heretofore cloth, coals, or horse-power. And yet we have noticed a tendency now and then in technical journals, on the part of men of practice, evidently ignorant of the history of the science they apply, to depreciate unduly the services of their theoretical brethren. One would have thought that in electrical science, beyond all others, where the mutual obligation is so great and so equally balanced, the folly of either the man of theory or the man of practice attempting to minimise the services of his fellow worker would have been evident.

The seal has been set to the work of the B.A. Committee by the Congress of Electricians which met last autumn in Paris, by the adoption of the B.A. units as the basis of an international system. To this result Maxwell's treatise has powerfully contributed, but it would be little in the spirit of its author to boast of this as a national, much less as his personal triumph; it is more fitting to remind the readers of NATURE that in the work thus consummated the English electricians were the followers of Gauss and Weber, and, more remotely, the disciples of Coulomb, Poisson and Ampère, so that they have simply acted up to the motto of all true scientific men, λαμπάδια ἔχαντες διαδώσουσιν ἀλλήλοις; they have but passed the torch from hand to hand.

The electromagnetic theory of light formed a fitting crown to the first edition of Maxwell's Electricity. It was left by its author in the form of a general sketch, carried just so far as was necessary for comparison with experiment. Concerning the progress of this theory during the last eight years much might be said, and it is greatly to be regretted that we have not before us what Maxwell himself would undoubtedly have said, had he lived to superintend the publication of the second volume of his work. It has formed the basis, as every good physical theory should, for a large number of further researches, both theoretical and experimental. We need only mention the work of Helmholtz, Boltzmann, Rayleigh, Silow, Hopkinson, Fitzgerald, Glazebrook, J. J. Thomson, and many others. The theory has not proved, and its author certainly never expected it to prove, a framework ready made with appropriated pigeon-holes, into which would naturally fall every electrical fact to be discovered in all time coming; but it has proved itself, so far, the best theory with anything like a physical basis that has been proposed to explain the facts with which it deals. The more it has been worked out, the more it has been found to explain in a natural way the known phenomena of electricity and light; and it does not appear to have been shown as yet that there is any observed fact that may not ultimately be reconciled with it, either by farther development of the theory, or by deeper probing of the experimental results. This is really all that could be expected when we reflect that, much as we know about electricity, there is an infinity yet unknown.

We have now to allude briefly to the changes that have been made in the second edition.

In the introductory chapter we are glad to see that few changes have been made; we need, therefore, only recommend our readers to peruse it again, as perhaps the most admirable thing of the kind that has been written in any language; we direct their attention more particularly to the distinctions drawn between electricity, force, and energy, of which some of our scientific men seem strangely oblivious, and to the admirable remarks on the two fluid theory. We must at the same time warn the student as to a radical change that has been introduced into the terminology of the subject. He is aware that at every point of the electric field there is conceived a directed quantity, which in the former edition of this work was called resultant electric force, or the electromotive force *at the point*, according as it was regarded from the ponderomotive or electromotive point of view, and he is also aware that the electromotive force *at a point* was a very different thing from the electromotive force *between two points*, the latter being in point of fact of different dimensions. It was always difficult, even for those who clearly understood the distinction, to avoid occasionally using the one term where the other was appropriate. Most probably from a feeling of this difficulty, our author has substituted for the two first of these terms *resultant electric intensity and electromotive intensity* respectively, wisely leaving the old established terms *electromotive force between two points* with its original meaning, although in point of fact it involves an abuse of the word *Force*. We could have wished the danger of confusion still more effectively barred by dropping the word "electromotive" in the first case altogether; but a more serious objection to this change is, that the author evidently intended, from his foot-note on p. 72—

> "The electric and magnetic intensity correspond in electricity and magnetism to the intensity of gravity, commonly called g in the theory of heavy bodies,"

to have made a corresponding change of terminology in the case of magnetism; whereas on turning to the second volume we find intensity of magnetisation used in its old

sense, and (resultant) magnetic force used in the sense in which magnetic intensity occurs in the above note, and, what is worse, in place of electric intensity or electromotive intensity we find on, p. 239, "electromotive force," and on p. 244, "electromotive force at a point" used in its place. This result of the interruption of the issue of the new edition is unfortunate, for it renders the confusion of terms greater than ever, and affords a kind of cover to those who excuse or justify the inaccuracy of their own ideas by appealing to the terminological inconsistencies of standard works. Yet we can scarcely blame the editor, for it is a very delicate matter to interfere with another's work, even in points like this.

The want of definiteness in electrical terminology makes itself felt in the definition of the electric strength of a dielectric; thus we find, on p. 51—

"The value of the electromotive force which can exist in a dielectric without a discharge taking place, is called the electric strength of the dielectric."

And again on p. 54:—

"The intensity of the electromotive force when this takes place is a measure of what we may call the electric strength of the dielectric."

Assuming for a moment that any accurate definition of electric strength can be given, which at present, experimentally speaking, is open to doubt; or, which comes to the same thing, taking, as Maxwell probably means us to do, an ideal case, the second of these definitions is right, if we understand by intensity of the electromotive force resultant electric intensity, or electromotive intensity, as previously defined; while the first, strictly read, *i.e.* taking electromotive force to mean the electromotive force between two points, is clearly wrong; for, if it were right, a spark would always pass between two conductors in the same medium when the difference of potential between them is the same, no matter what their form or surroundings, which is well known to be untrue.

In this connection we may mention that the account formerly given of Thomson's classical experiments on the electric strength of air no longer finds a place in Art. 57. No doubt the author had intended to describe them later on along with what has been done of late in the same direction; but no mention of them occurs, except a cursory one in Art. 59; yet we are still referred in Art. 369 to Art. 57 for the account which is no longer there. It is a pity that a footnote was not inserted referring the reader to the reprint of Thomson's papers.

In Chapter II. we may note, as new, an interesting account of Cavendish's experiment, on which, mainly, we may now rest the evidence for the elementary law of electrostatic action; a simplification of the treatment of the variation of the potential at charged surfaces; farther direct application of the theory of lines of force in proving electrical theorems of considerable interest and generality; and a clearer explanation than was formerly given of the distinction between the real electrification according to the medium theory and the apparent electrification which may be used to represent it, if we abstract the specific inductive capacity of the dielectric.

Chapter III. has been in great part rewritten, and several very interesting and practically useful calculations of the approximate values of coefficients of induction and potential have been added. In Chapter IV., which contains the general theory of electrical equilibrium, the changes have been greater still; the result has been, on the whole, we think, considerable simplification; it would appear, however, from the way in which the chapter ends, that the author had contemplated some farther additions. Chapter IX. has also been greatly modified; in particular the problem of two spheres has been worked out in great detail, and series given to a high degree of approximation for the coefficients of induction and potential.

The rest of the work is practically a reprint from the former edition, and calls for little remark. We may, however, call the attention of our readers to Art. 261, the ideas and notation of which will, we believe, be found discordant with the best modern chemical views.[1] The editor has very properly appended a note to Art. 357, calling attention to Mr. Lodge's exposure of the fundamental defect of Mance's method (in the *Philosophical Magazine* for 1877, not 1857, as the reference is printed). Mr. Lodge's remarks are, so far as we know, the first published allusion to the matter, but the defect in question was well known to Prof. Clerk Maxwell, for it was discussed with him by the present writer some time before the above date. It used to be not uncommon to set over-confident students in the Cavendish Laboratory the problem of measuring the internal resistance of a battery, and then to explain to them the reason of the hopelessly indefinite character of the results obtained under certain circumstances by Mance's method. Notwithstanding Mr. Lodge's remarks, one sees, even in the most recent text-books, this method confidently cited as apparently irreproachable.[2] So tenacious is scientific error! Another correction we may mention—the interlacing circuits in Art. 421 *are* now so arranged that the integral $\iint \Pi \, ds \, d\sigma$ vanishes.

Before taking leave of the work, we have to express the gratitude which the scientific public owes to its editor, Mr. Niven. It has been our duty to indicate some points in which there might have been improvement, and we have said little as to what has been actually done by Mr. Niven. It is but justice to him, therefore, to add that we went over the new edition, and compared it with our copy of the first edition, and we found that in almost every case the errors we had noted were corrected, while explanations had been inserted at many of the places where we had found them necessary. The labour involved in doing all this will be best understood by those who are perfectly familiar with the whole of Maxwell's great work, and all such will know how to appreciate the conscientious labour which Mr. Niven has so unostentatiously bestowed on the editing of this edition.

The regret one feels that Prof. Maxwell did not live to complete his work is much increased when we read the elementary treatise. In the earlier parts it is characterised by that originality, freshness, and exemplary clearness familiar to the readers of his Heat. Chapters I. and II. reproduce with more ample experimental detail the admirable introduction to the larger work. Chapter III. gives the mathematical theory of electrical work and energy in a form accessible to students of moderate mathematical acquirements, although such need not expect to

[1] This applies also to the corresponding passage in the elementary work.

[2] It is unfortunate that Mr. Garnett should have transferred the description of Mance's method to the Elementary Treatise, without correcting or alluding to the error it contains.

find it easy reading. Chapter IV., on the exploration of the electric field is perhaps the most interesting in the book; its contents will be familiar to those who heard the lectures of its author, but much of it is new to the scientific public. Chapter V. contains the theory of Faraday's lines of electric induction, and here for the first time the reader begins to feel that the matter must have been left in a state more or less unfit for publication. The text reads more like a series of disjointed notes than a coherent treatise, and the admirable simplicity and symmetry of treatment which characterises the earlier part of the work is lost. Still, what we have is of great interest, and will be invaluable to a good teacher in giving him hints how to arrange an elementary exposition of Faraday's theory. Chapters VI., VII., and VIII. are more complete, and will be very useful in giving to beginners in electricity some idea of the applications of the mathematical theory; Chapter VIII., on capacity, is one likely to be particularly useful, as it deals with one of the fundamental ideas in electrical measurement. We recommend it all the more, as we have seen the term capacity both ill defined and loosely applied in recent treatises. Chapters IX. and X., fragmentary as they are, are full of interest to those who have studied the larger work; for they throw much light upon many points concerning which the author had formerly but briefly indicated his opinion. We may mention more particularly his remarks on the vexed question of contact electromotive force; also, as new, and specially interesting, the experiments on the insulating power of air and other gases, Art. 138, *et seq.*

The rest of the book is a series of extracts from the larger work, concerning the utility of which, in their present form and arrangement, there will be difference of opinion.

In the interest of the author's reputation it might have been better to have published simply what he had left in MSS. in a more confessedly fragmentary form. If, however, the additions that have been made will secure the use of the treatise by elementary teachers, we shall rejoice; for some of the manuals which they use are not remarkable either for scientific method or for the extent and accuracy of their information; in fact the study of many of them, far from introducing the learner to the science of electricity, is simply a waste of his time.

G. CHRYSTAL

OUR BOOK SHELF

The Zoological Record for 1880; being vol. xvii. of the Record of Zoological Literature. Edited by E. C. Rye, F.Z.S. (London: John Van Voorst, 1881.)

WE heartily congratulate the editor on his praiseworthy success in publishing this important Record of Zoological Literature for 1880 before the termination of 1881. It is the first time, as the editor himself reminds us, that this event has taken place since 1870, and now we trust it will be once more the usual plan. So far as we have been able, by looking here and there throughout the volume, to ascertain, this expedition has not been at the expense of accuracy; and as to incompleteness, any omissions are very easily supplied in the next volume. The Recorders are nearly the same as for 1879, Mr. G. A. Boulenger taking the place of the late Mr. O'Shaughnessy, and reporting on the reptiles, batrachians, and fishes. Mr. W. A. Forbes gives us an admirable report on the mammals. This and Mr. Howard Saunders' report on the birds leave little to be desired in either the arrangement of the matter or in the terseness and yet clearness of the notices. The latter Recorder adopts P. L. Sclater's systematic arrangement as laid down in the important paper by Dr. Sclater "On the Present State of the Systema Avium." The mollusca and molluscoida are reported on by Prof. Ed. von Martens, who also gives the record of the crustacea. These we venture to regard as the model reports of the volume. After a pretty full list of the publications relating to the group recorded, we find a list of the special journals and manuals relating to the class. Then under the heading of Anatomy and Physiology, we find most interesting summaries of the additions made to a knowledge of the general morphology, muscular system and movement, shell formation, digestion, excretion and secretion, nervous system, organs of sense, of generation, embryology, abnormities, and even on the action of poisons. After this some details of the geographical distribution, and of the recently-described forms. The amount of labour spent over this most useful grouping of details on the part of the recorder is great, but the reader reaps from it an immense benefit. The literature of the arachnida is recorded by Rev. O. P. Cambridge, with the assistance of Mr. F. M. Campbell. To Mr. Kirby falls the larger share of the Record of the insecta; indeed all the orders save the neuroptera and orthoptera, which fall to Mr. McLachlan's share are reviewed by him. The vermes and echinoderms are recorded by Prof. Bell; the hydrozoa and cœlenterata by Mr. A. G. Bourne; the anthozoa by Mr. S. J. Hickson; while the literature of sponges and protozoa is recorded by Mr. Stuart O. Ridley. From a summary appended by the editor we find that this volume contains a record of no less than 1008 new genera and sub-genera, described as follows:—

Mammalia	34	Myriopoda	2
Aves	16	Insecta	438
Reptilia	21	Vermes	28
Pisces	31	Echinodermata	24
Mollusca and Molluscoida	79	Coelenterata	70
Crustacea	80	Spongiida	51
Arachnida	78	Protozoa	56

a goodly number, going even beyond the average of most years.

Land und Leute in der brasilianischen Provinz Bahia. Streifzuge von Julius Naeher. (Leipsig: Gustav Weigel, 1882.)

THE author essays, in a small volume of not quite 300 pages, to write a Guide to the Province of Bahia. Starting from Hamburg he steamed, *viâ* Lisbon, the Canary and Cape de Verd Islands, to Brazil, and he asserts that he found the steamers on this route excellent. The details of all the other routes from Europe are, however, also given. As the work is the result of the author's own observation, it only describes a small part of the Brazils. It affords a graphic insight into the tropical vegetation of the country, and gives many details as to the sugar plantations. The social life he did not find to differ much from that described in the older books of travel; only the Indians and the wild beasts were less numerous and troublesome. In Bahia about one-fifth of the population belonged to the white race, while about one-half were pure negroes, and the rest were half-castes. While the author does not profess to give a scientific description of the products of this province, he still has evidently paid a good deal of attention to the fruits and other produce of the colony, and in many cases gives statistics as to the present value of these. The gradual abolition of slavery is beginning to hamper the cultivation of sugar, and the great question of the day will no doubt soon be, How is the agriculture of the country, to which so much of the wealth of the country is at present due, to be kept up when slave labour comes to an end?

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

A Glimpse through the Corridors of Time

IN a letter which appeared in last week's NATURE (p. 217), Dr. Dupré refers to a "too much forgotten paper by Immanuel Kant," and speaks of Kant's contributions to natural science as being, at present, "almost universally overlooked."

Whatever may be the case elsewhere, I do not think that, in England, we are open to this reproach, inasmuch as in the year 1869, when I had the honour to be President of the Geological Society, a very considerable portion of my anniversary address "On Geological Reform" was devoted to an attempt to do justice to Kant's work, and to indicate the high place which it occupies in the history of scientific geology. The address is reprinted in my "Lay Sermons," and therefore I have reason to know that a considerable proportion of the reading, or at any rate book-buying, public has no excuse for "overlooking Kant's work."

I may remark, in passing, that, so far as my knowledge extends, the extreme "Uniformitarianism" which Prof. Ball attacks, has long been as much "a creed outworn" as "Plutonism" or "Neptunism." Indeed, I said as much in 1869.

T. H. HUXLEY

Normal School of Science and Royal School of Mines, South Kensington, January 8

Outburst of Sun-Spots, July 25, 1881

MY letter of August 5, 1881, which appeared in NATURE, vol. xxiv. p. 508, stated that a considerable group of sun-spots burst into appearance between 4 and 5 p.m. (about) on July 25, 1881; or more exactly that the new group was absent at 3h. 58m. (*i.e.* in negative No. 1175), but was present at 4h. 47m. (*i.e.* in negative 1176), local apparent time; further, that no additional negatives could be taken here until July 30, when the spots had disappeared.

This communication has elicited obliging notices by other observers, including Prof. Piazzi Smyth and Prof. Perry, F.R.S., in NATURE, besides others posted to me direct. The observers were not able to observe the sun when the outburst occurred, nor for some twenty-two hours afterwards; none of the observers saw the new group.

One of the observers remarks: "I fancy your sudden group of spots is after all a curious system of blemishes in the negative!" Certainly the appearance of the negative (No. 1176) did not (to me) admit of conjectures suggesting the *unreality* of the spots. However, in presence of the remark now offered, I made inquiries of the photographer, Mr. L. H. Clarke, as to the circumstances connected with his detection of the outburst. I inclose his narrative (see below). It establishes the fact that he *first* saw the new spot-group *on the ground-glass slide* used for focussing the photoheliograph, and indeed that it was *this view* of the unexpected event which urged him to persevere (notwithstanding the clouded state of the sky) in securing a negative, *i.e.* No. 1176, on which the new spot-group he had seen on the ground glass slide stands photographed. His narrative further establishes narrower limits of time in which the outburst occurred, *i.e.* between 3h. 58m. to about 4h. 35m., instead of to 4h. 47m. p.m.

I communicate the foregoing facts, as they are essential circumstances of the event, and should be placed on record.

J. B. N. HENNESSEY

Debra Doon, N. W. Provinces, India, December 16, 1881

On July 25, 1881, the sun was quite invisible owing to clouds, until towards 4 p.m., when a temporary break occurred, and I took negative No. 1175 at 3h. 58m. p.m. After this the sun again became invisible, while the rising clouds were so dense as to present little hope of getting another negative; so, as evening was approaching I was thinking of closing work for the day, when, while I was still watching at the instrument, an unexpected opening occurred in the rising clouds below the sun, and, soon after, the sun's image appeared on the ground glass used for focussing. To my surprise I now saw, at about 4h. 35m. p.m., a large group of spots about the sun's centre, which were quite absent in the previous negative, No. 1175; little expecting anything of the kind, or indeed to see the sun at all that evening, I was not ready to expose a plate, but now seeing what had happened, I determined to persevere, though the clouds were very unpromising of another break. So I at once took points on my blue setting glass, as is usual to set the instrument by (so as to avoid needless hiding of spots behind the wires), and having done this, I prepared a plate as quickly as possible, and set the exposing slide all ready, though the sun now was invisible; fortunately another opening occurred at 4h. 47m. p.m., when I took negative number 1176, in which appears the group of new spots about the sun's centre, which new group I saw without doubt at about 4h. 35m. on the ground glass for focussing. I then continued to watch for another negative until 5h. 30m. p.m., when the sky having become quite dark, I gave up work for the day.

L. H. CLARKE

December 2

Polymorphism of the Flower-heads of Centaurea Jacea

IN *Centaurea Jacea*, the flower-heads of the same stem, as far as I have seen, are always of the same form, but different stems of the same locality often present astonishing difference in their flower-heads.

In the most common and apparently original form the flower-heads consist of florets which are all of the same tubular shape and all contain both fully developed anthers and stigma, the divergence of the outer florets giving to the whole head a diameter of 20–30 mm. (see H. Müller, "Bie Befruchtung der Blumen," p. 382–384). From this original form variation has gone on in two opposite directions, the final effects of this variation being on the one side most conspicuous male flower-heads of 50–55 mm. diameter, and on the other side less conspicuous female flower-heads of 30–35 mm. diameter. In both these extreme forms the outer row of florets possesses greatly enlarged radiating corollas which are sexually functionless, but useful in making the flower-mass more conspicuous. In the male flower-heads anthers and pistils of the disk-flowers are well-developed, but the style-branches never open so as to expose their stigmatic surfaces, and in their basal portion are grown together. In the female flower-heads, on the contrary, only the pistil of the disk-flowers is fully developed, the anthers being pollenless, shrivelled, and brownish-coloured.

These two extreme forms are linked with the original one by a continuous series of gradations. When in the original form variation begins in the one direction, the outer row of florets gradually becomes longer and more radiating, and in the same degree their sexual organs diminish in size and become functionless, the anthers first aborting, and then the pistil. Finally, the barren ray-florets continuing to increase, the pistils of the disk-florets, too, become functionless, and the conspicuous male flower-head is accomplished.

In the contrary variation some of the outer florets of the original form begin to diminish in size, while their anthers become brownish and pollenless, and this change step by step proceeds inwards and seizes a greater and greater number of disk-florets, until the whole flower-head is female, and reduced to a diameter of 15–18 mm. This state being reached, the corollas of the marginal flowers recommence to increase and become radiating, while in the same time their anthers disappear without leaving any trace, and their style-branches remain closing together.

These are, shortly sketched, the main varieties of *Centaurea Jacea*, near Lippstadt. Further details are about to be published in one of the next numbers of *Kosmos*.

Lippstadt HERMANN MÜLLER

The Weather

THIS morning I noticed the first blossoms of the Colt's-foot (*Tussilago farfara*), ordinarily considered an indication of the near approach of spring. For many years a generous rivalry has existed between myself and a friend (both travellers on the

North Kent Railway, on the banks of which the plant is excessively abundant) as to which could record the first blossoms. I think I have seen them as early as the first week in February; on the other hand, it is possible that the first week in April is on record as the earliest appearance; almost without exception it truly indicated that any long period of severe weather was over for that winter. Will this prove the case with the so-called "winter" of 1881-1882?

Lewisham, January 6 R. McLachlan

Indian Fossils.—Dr. Gordon, of the Manse, Birnie, Elgin, writes that there is a pretty large collection of Siwalik fossils in the Falconer Museum at Forres, N.B.

THE TRANSIT OF VENUS IN 1882

THE French Ministry of Public Instruction has issued the *Procès-verbaux* of the International Conference on the approaching Transit of Venus, held at Paris from the 5th to the 13th of October last. Representatives of fourteen nationalities were present at the Conference, but regret was expressed that the United States had no delegate present Russia; also was unrepresented, but it has been understood that the Government of that country do not propose to organise expeditions beyond the limits of the Empire, or perhaps to undertake observations elsewhere than at the fixed observatories. M. Jules Ferry, then Minister of Public Instruction and the Fine Arts, was present at the opening meeting of the Conference on October 5, and stated its objects; he was named honorary president by acclamation, and on his proposition the meeting proceeded to the election of the acting-officers, which resulted in the choice of M. Dumas, perpetual secretary of the Academy of Sciences of Paris, as president; Prof. Fœrster, director of the Observatory of Berlin, and Prof. Weiss, director of the Observatory of Vienna, as vice-presidents; with M. Hirsch, of the Observatory of Neuchâtel, delegate from the Swiss Republic, and M. Tisserand, the proposed chief of a French expedition to Martinique, as secretaries. M. Dumas pointed out that the expeditions in 1874 were organised by the various nations without any general previous understanding, each acting independently, adding that the necessity of cooperation in the arrangements of different countries for the observation of the approaching phenomenon is now generally admitted. He directed special attention to the desirability of coming to some definite conclusion as to the employment or otherwise of photography on the occasion. In the discussion which followed Prof. Fœrster announced that the German Commission had resolved not to employ photography in 1882, and Mr. E. J. Stone, the Radcliffe Observer, directing astronomer of the British Commission, which he represented at the Conference, mentioned that it was not seriously intended to introduce photography in the expeditions of 1882, remarking that the French results from this method were not encouraging, and the American results had not been published in time to allow of due discussion before the British Commission was called upon to advise the Government on the best methods of observing the transit.

M. d'Abbadie, however, reminded the Conference that good results had been obtained by Mr. Todd from the American photographs. M. Hirsch said the scientific public had been surprised to find that after the lapse of seven years since the transit of 1874 there was yet but a partial publication of results, and these in small number: each nation had given its solar parallax, but could not a different method of procedure be adopted for the transit of 1882? It might be worth while to form a *bureau des calculs*, charged to collect, reduce, and discuss the whole of the observations in 1882, and the same bureau might also discuss the entire series of observations at the late transit, and publish the final value of the sun's parallax from the two transits. Prof. Fœrster took a similar view; Prof. Oudemanns preferred that each commission should in the first place draw up and publish its separate report; the definitive parallax would follow. At the second sitting of the Conference on October 6 M. Dumas notified the stations selected by the French Commission and the observers whom it was proposed to place in charge of the respective expeditions. At three of the stations, viz., Santa-Cruz, Rio Negro, and Port-Desire or Chubut, in Patagonia, M. Mansilla from the Argentine Republic, said the French expeditions might count upon the co-operation of his Government, and the same was stated as regards Santiago, another of the French stations, by Dr. Moesta on the part of the Government of Chile. M. Liais, delegate from Brazil, mentioned that M. Cruls would observe at Rio Janeiro, where the sun would be nearly in the zenith soon after the second contact; he had also organised a station in a locality situated at an altitude of 1800 metres to guard against unfavourable weather at Rio, and a third station would be at Pernambuco, where the chances of a clear sky are very great; further, M. Liais contemplated two additional stations, one of them in the Straits of Magellan; the telescopes employed in Brazil would be of 9 inches and 6 inches aperture. Prof. Fœrster stated that the German Government had not finally decided upon the precise localities to which the four authorised expeditions would be sent, but it had been proposed to place two of them in the southern part of the United States, one in the south of the Argentine Republic, and the fourth at the Falkland Islands. With regard to observations in the Straits of Magellan, M. Bouquet de la Grye, of the French Navy, said the Chilian Government had for a long time past instituted meteorological observations which, while they indicated that the probabilities of a fine sky were great at Santiago, were not promising for the Straits: "Il n'y a peut-être pas une probabilité de $\frac{1}{10}$ de voir une partie seulement du phénomène." Prof. Fœrster stated that according to his information, there existed near the Magellan Straits very limited localities where the conditions would be favourable in December. With regard to the Antilles, to which expeditions were intended to be sent, the conditions, according to M. Bouquet de la Grye, were complicated: at Martinique they would be pretty good, as also for Florida; at Cuba moderately so; on the coasts of the Gulf of Mexico the chances of fine weather are small, though improving in the interior. M. Pechüle of Copenhagen said the Danish Government proposed, with the assent of the Chambers, to equip an expedition either to St. Croix or St. Thomas. Dr. Bakhuysen said, although the Netherlands Government had not made a final decision, it was proposed to send an expedition to Curaçao or St. Martin in the Antilles, and a heliometer would form part of the equipment. M. Viegas, delegate from Portugal, remarking that the weather is usually magnificent in December n that country, mentioned that the observatories of Lisbon and Coimbra possessed large equatorial instruments, and suggested, if it were considered of utility, an expedition might be placed in the Portuguese colonies, at Benguela, for example. Mr. Stone reported upon the selection of stations by the English Commission, the principal centres being the Cape, Australia, New Zealand, and the Antilles. On the part of the Spanish Government, M. Pujazon, director of the Naval Observatory at San Fernando, said it was intended to organise two stations, one at Porto Rico, the other in the southern part of Cuba, where the chances of favourable weather will be considerable: equatorials of 6-inches (English) aperture to be supplied. At the same sitting of the Conference, M. Dumas proposed the nomination of two committees, the one to be charged with the distribution of the observing-stations, the other with the methods and instruments of observation; it had been previously pointed out by M. d'Abbadie that he was named to conduct an expedition to Cuba on the part of the French Government, where it was now

stated one would also be sent by Spain: the duplication of stations is not desirable in such a case. The President's propositions were adopted, but in addition the Committee on Methods was also charged with the consideration of the calculations and publication of the observations in 1882, and were further deputed to consider the formation of a temporary international bureau, to be intrusted with the reduction of the whole of the observations. At the fifth and last sitting of the Conference on October 13, the report from the Committee on Methods of Observation, &c., was presented. The proposals of the British Commission respecting the phenomena to be noted at the contacts of the limbs of the sun and Venus, brought forward by Mr. Stone, were made the foundation for a series of instructions to observers, some explanations being appended thereto. After much divergence of opinion with regard to the advantage of an international *bureau des calculs*, the following proposition introduced by M. Dumas, and supported by Mr. Stone on the part of the English commission, was adopted by a large majority.

"The Conference expresses the wish that the French Government may be willing to communicate in diplomatic form with the other governments represented in this conference, or those who are interested in the transits of Venus, in order to lay before them the proposition of convoking, after the return of the expeditions of 1882, an international conference on the transits of Venus, with a view to establish an understanding on the means to be adopted to arrive at the best and most expeditious use of the observations of the transits of 1874 and 1882, and in particular to inquire whether towards this end a temporary international bureau should not be formed."

The report closes with a list of the projected stations for the expeditions, so far as at present arranged. The British stations selected are:—Bermuda, Jamaica, Barbados, Cape Colony (3), Madagascar, New Zealand, Falkland Islands (?), with the Australian observatories.

ON THE PHYSICAL CAUSE OF THE OCEAN BASINS

GEOLOGISTS have reason to thank Prof. Ball for directing their attention to the remarkable investigations of Mr. G. H. Darwin upon "The Precession of a Viscous Spheroid, and the Remote History of the Earth," (*Phil. Trans.* Roy. Soc., Part ii., 1879). Prof. Hull has already been led to point out one result which appeared to him to flow from them, in showing how the ancient tides may have produced the planes of marine denudation, though Mr. Darwin has since expressed doubts as to the legitimacy of this conclusion. I wish to offer another speculation arising from Mr. Darwin's work, which I think may account for the hitherto unexplained distribution of land and water upon the surface of the globe.

Herschel remarked long ago, in his "Physical Geography," that the prevalence of land and water over two opposite hemispheres "proves that the force by which the continents are sustained is one of *tumefaction*, inasmuch as it indicates a situation of the centre of gravity of the total mass of the earth somewhat eccentric relatively to that of the general figure of the external surface —the eccentricity lying in the direction of our antipodes: and is therefore a proof of the comparative *lightness* of the materials of the terrestrial hemisphere." In my "Physics of the Earth's Crust," just published, I have shown reasons for thinking that the distribution of the materials of the earth, which gives rise to this condition, is of the following kind. I accept on the whole the theory that the earth is a hot globe, of which the superficial crust is rendered solid by having become cool, and that the central part is solid, either from great pressure, or from whatever other cause may be assigned; an intervening layer beneath the cooled crust still remaining liquid. The layers of which the whole is composed are arranged in order of their density. Now I have given reasons for believing that Herschel's "comparative lightness of the materials of the terrestrial hemisphere" arises from the fact that the cooled crust beneath the continents is intrinsically less dense than that beneath the great oceans. I think that the crust beneath the continents consists of the cooled acid, or granitic, and therefore lighter magma, which ought naturally to have formed originally the entire superficial portion of the globe. But I conclude that the bottoms of the great oceans consist nevertheless of a crust formed out of the cooled basic layer. Beneath the cooled crust the laws of hydrostatic equilibrium would require that, if the substratum is truly liquid, it should be of the same density under both these areas. I also conclude that the upper surface of the basic crust which forms the floor of the oceans is really depressed below the mean surface of figure.

To these conclusions I arrived without being able to suggest any satisfactory explanation of the facts. I saw that they agreed with, and were supported by, the view of those geologists who assert that the great oceanic and continental areas have never changed places; but neither could I any better see the reason for this.

Let us now inquire whether Mr. Darwin's researches throw any light upon the subject. I shall refer chiefly to the summary and discussion of results appended to his paper, for it is small blame to a sexagenarian, not a professed mathematician, to admit that to follow the *calculations* is beyond the scope of his powers. As I understand Mr. Darwin, he thinks it probable that the moon and the earth were once a single mass, and that at the time when this mass was rotating at the rate of about one revolution in five hours the whole separated into two portions, the smaller of which went to form the moon; and that the moon then began to recede from the earth, until now, after the lapse of fifty-four millions of years *or more*, it is at its present distance. The ellipticity of the mass when rotating at the above-named speed would be about 1-12th. [This would make the mass very much less compressed than an ordinary orange.] He does not think it probable that this amount of ellipticity would cause the spheroid to break up simply from the centrifugal effect of the rotation; but he suggests, judging from the calculated period of a gravitational oscillation of a fluid spheroid, of uniform density equal to the mean of the earth, viz. 1 hour 34 minutes, that the period of the free oscillation of a spheroid "consisting of a denser nucleus and a rarer surface," but of the same mean density as the earth, might coincide with the period of the bodily solar tide at that time. "It seems to be quite possible that two complete gravitational oscillations of the earth in its primitive state might occupy four or five hours." "Accordingly the solar tides would be of enormous height." He then adds: "Does it not then seem possible that, if the rotation were fast enough to bring the spheroid into anything near the unstable condition, then the large solar tides might rupture the body into two or more parts? In this case one would conjecture that it would not be a ring that would detach itself."

I now proceed to build my speculation upon his. It is obvious that, according to the above theory, the act of fissiparturition by which the moon was born must have been sudden. One of the two solar tidal protuberances broke away from the earth to inchoate a separate existence. A great but shallow hole must consequently have been formed, whose centre would have been on or near the equator. Prof. Ball says: "Not for long would that fragment retain an irregular form; the mutual attraction of the particles would draw the mass together. By the same gentle ministrations the wound on the earth would soon be healed. In the lapse of time the earth would become as whole as ever, and at last it would not retain even a scar to testify to the mighty catastrophe."

I form a less hopeful prognostication. I think the ocean basins are the scar, which still testify to the place of separation.

The density of the moon is 0·56654 times that of the earth. Putting the mean density of the earth at 5·5, this makes the density of the moon 3·1. The density of granite is about 2·68, and that of basalt 2·96. Consequently the density of the moon is a little greater than that of the basic layer of the earth's surface, which I think we may expect to occur at the sea-board at a depth of about 25 miles. The entire mass of the moon is 0·011364 of the mass of the earth.

Accordingly, it would require a layer of about 31 miles thick, of the density of granite, to be taken off the surface of the primitive mass to make a body of the mass of the moon; and if the mean density of the matter removed was the same as that of the moon, a somewhat thinner layer would suffice. But if we reduce the area of the skin removed to the area of the oceans, it would require to be $\frac{197}{146} \times 31$, or about 41 miles deep. Hence a uniform layer rather less than 41 miles thick taken off the oceanic areas would be sufficient to make the moon.

Of course the layer removed would not, in fact, have been of uniform thickness. But the above estimate gives an idea of the size of the cavity which would be produced. What then would happen? This would depend upon whether the surface had already become at all solid. I conceive this would be the case at a very early stage, judging from the manner in which a solid layer forms on the liquid lava of Kilauea. The hole would therefore fill up by the rise of the liquid from below, rather than by the lateral approach of the edges of the wound. When the raw surface again solidified we should have a crust of greater density over the area in question, because formed from a lower and denser layer, which would have risen not quite to the level of the lighter crust. There would, however, have necessarily been a certain amount of flow in the upper fluid layers towards the cavity, and this would have carried the cooled granitic crust which, floating on it, still remained upon the earth along with it. What was left of the granitic crust would therefore be broken up into fragmentary areas, now represented by the continents. This would make the Atlantic a great rent, and explain the rude parallelism which exists between the contours of America and the Old World.

The sudden rupture of so considerable a fragment from the rotating spheroid, would alter its mass, form, and moment of momentum. It appears then that its axis of rotation would be altered, which might account for the fact, that the approximate pole of the oceanic area is not in the equator.

The volcanic surface of the moon, if volcanic it be, would lend considerable support to the view which I maintain, that the water substance emitted by volcanoes is an integral constituent of the fluid substratum. For when the moon broke away from the earth it would carry with it the aqueous constituent of the magma. Owing to the much smaller force of gravity in the moon, the pressure under which this would there be placed would be much less than in the earth. Consequently it would more easily escape, and the signs of volcanic action would be more pronounced. But the difficulties surrounding terrestrial vulcanism are so great, that one is hardly tempted to add the lunar to them. O. FISHER

CLASSIFICATION OF THE DINOSAURIA[1]

IN the May number of the *American Journal of Science* (p. 423) I presented an outline of a classification of the Jurassic Dinosaurian reptiles of this country which I had personally examined. The series then investigated is deposited in the Museum of Yale College, and consists of several hundred individuals, many of them well preserved, and representing numerous genera and species. To ascertain how far the classification proposed would apply to the material gathered from wider fields, I have since examined various Dinosaurian remains from other formations of this country, and likewise during the past summer have visited most of the museums of Europe that contain important specimens of this group. Although the investigation is not yet completed, I have thought the results already attained of sufficient interest to present to the Academy at this time.

In previous classifications, which were based upon very limited material compared with what is now available, the Dinosaurs were very generally regarded as an order. Various characters were assigned to the group by von Meyer, who applied to it the term *Pachypoda*; by Owen, who subsequently gave the name *Dinosauria*, now in general use; and also by Huxley, who more recently proposed the name *Ornithoscelida*, and who first appreciated the great importance of the group, and the close relation it bears to birds. The researches of Leidy and Cope in this country, and Hulke, Seeley, and others in Europe, have likewise added much to our knowledge of the subject.

An examination of any considerable portion of the Dinosaurian remains now known will make it evident to any one familiar with reptiles, recent or extinct, that this group should be regarded not as an order but as a sub-class, and this rank is given it in the present communication. The great number of subordinate divisions in the group, and the remarkable diversity among those already discovered indicate that many new forms will yet be found. Even among those now known, there is a much greater difference in size and in osseous structure than in any other sub-class of vertebrates, with the single exception of the placental Mammals. Compared with the Marsupials, living and extinct, the *Dinosauria* show an equal diversity of structure, and variations in size from by far the largest land animals known—fifty or sixty feet long, down to some of the smallest, a few inches only in length.

According to present evidence the Dinosaurs were confined entirely to the Mesozoic age. They were abundant in the Triassic, culminated in the Jurassic, and continued in diminishing numbers to the end of the Cretaceous period, when they became extinct. The great variety of forms that flourished in the Triassic render it more than probable that some members of the group existed in the Permian period, and their remains may be brought to light at any time.

The Triassic Dinosaurs, although so very numerous, are known to-day mainly from footprints and fragmentary osseous remains. Not more than half-a-dozen skeletons, at all complete, have been secured from deposits of this period; hence, many of the remains described cannot at present be referred to their appropriate divisions in the group.

From the Jurassic period, however, during which Dinosaurian reptiles reached their zenith in size and numbers, representatives of no less than four well-marked orders are now so well known that different families and genera can be very accurately determined, and almost the entire osseous structure of typical examples, at least, be made out with certainty. The main difficulty at present with the Jurassic Dinosaurs is in ascertaining the affinities of the diminutive forms which appear to approach birds so closely. These forms were not rare, but their remains hitherto found are mostly fragmentary, and can with difficulty be distinguished from those of birds, which occur in the same beds. Future discoveries will, without doubt, throw much light upon this point.

Comparatively little is yet known of Cretaceous Dino-

[1] By Prof. O. C. Marsh. Read before the National Academy of Sciences, at the Philadelphia meeting, November 14, 1881. Communicated by the Author.

saurs, although many have been described from incomplete specimens. All of these appear to have been of large size, but much inferior in this respect to the gigantic forms of the previous period. The remains best preserved show that, before extinction, some members of the group became quite highly specialised.

Regarding the Dinosaurs as a sub-class of the REPTILIA, the forms best known at present may be classified as follows:—

SUB-CLASS DINOSAURIA

Premaxillary bones separate; upper and lower temporal arches; rami of lower jaw united in front by cartilage only; no teeth on palate. Neural arches of vertebræ united to centra by suture; cervical vertebræ numerous; sacral vertebræ co-ossified. Cervical ribs united to vertebræ by suture or ankylosis; thoracic ribs double-headed. Pelvic bones separate from each other, and from sacrum; ilium prolonged in front of acetabulum; acetabulum formed in part by pubis; ischia meet distally on median line. Fore and hind limbs present, the latter ambulatory and larger than those in front; head of femur at right angles to condyles; tibia with procnemial crest; fibula complete. First row of tarsals composed of astragalus and calcaneum only, which together form the upper portion of ankle joint.

(1.) Order SAUROPODA (Lizard foot).—Herbivorous.

Feet plantigrade, ungulate; five digits in manus and pes; second row of carpals and tarsals unossified. Pubes projecting in front, and united distally by cartilage; no post-pubis. Precaudal vertebræ hollow. Fore and hind limbs nearly equal; limb bones solid. Sternal bones parial. Premaxillaries with teeth.

(1) Family *Atlantosauridæ*. Anterior vertebræ opisthocœlian. Ischia directed downward, with extremities meeting on median line.

Genera *Atlantosaurus*, *Apatosaurus*, *Brontosaurus*, *Diplodocus*, ? *Camarasaurus* (*Amphicœlias*), ? *Dystrophæus*.

(2) Family *Morosauridæ*. Anterior vertebræ opisthocœlian. Ischia directed backward, with sides meeting on median line.

Genus *Morosaurus*.

European forms of this order: *Bothriospondylus*, *Cetiosaurus*, *Chondrosteosaurus*, *Eucamerotus*, *Ornithopsis*, *Pelorosaurus*.

(2.) Order STEGOSAURIA (Plated lizard).—Herbivorous.

Feet plantigrade, ungulate; five digits in manus and pes; second row of carpals unossified. Pubes projecting free in front; post-pubis present. Fore limbs very small; locomotion mainly on hind limbs. Vertebræ and limb bones solid. Osseous dermal armor.

(1) Family *Stegosauridæ*. Vertebræ biconcave. Neural canal in sacrum expanded into large chamber; ischia directed backward, with sides meeting on median line. Astragalus co-ossified with tibia; metapodials very short.

Genera *Stegosaurus* (*Hypsirhophus*), *Diracodon*, and in Europe *Omosaurus*, Owen.

(2) Family *Scelidosauridæ*. Astragalus not co-ossified with tibia; metatarsals elongated; four functional digits in pes. Known forms all European.

Genera *Scelidosaurus*, *Acanthopholis*, *Cratæomus*, *Hylæosaurus*, *Polacanthus*.

(3.) Order ORNITHOPODA (Bird foot).—Herbivorous.

Feet digitigrade, five functional digits in manus and three in pes. Pubes projecting free in front; post-pubis present. Vertebræ solid. Fore limbs small; limb bones hollow. Premaxillaries edentulous in front.

(1) Family *Camptonotidæ*. Clavicles wanting; post-pubis complete.

Genera *Camptonotus*, *Laosaurus*, *Nanosaurus*, and in Europe *Hypsilophodon*.

(2) Family *Iguanodontidæ*. Clavicles present; post-pubis incomplete. Premaxillaries edentulous. Known forms all European.

Genera *Iguanodon*, *Vectisaurus*.

(3) Family *Hadrosauridæ*. Teeth in several rows, forming with use a tesselated grinding surface. Anterior vertebræ opisthocœlian.

Genera *Hadrosaurus*, ? *Agathaumas*, *Cionodon*.

(4.) Order THEROPODA (Beast foot).—Carnivorous.

Feet digitigrade: digits with prehensile claws. Pubes projecting downward, and co-ossified distally. Vertebræ more or less cavernous. Fore limbs very small; limb bones hollow. Premaxillaries with teeth.

(1) Family *Megalosauridæ*. Vertebræ biconcave. Pubes slender, and united distally. Astragalus with ascending process. Five digits in manus and four in pes.

Genera *Megalosaurus* (*Poikilopleuron*), from Europe. *Allosaurus*, *Cœlosaurus*, *Creosaurus*, *Dryptosaurus* (*Lælaps*).

(2) Family *Zanclodontidæ*. Vertebræ biconcave. Pubes broad elongate plates, with anterior margins united. Astragalus without ascending process; five digits in manus and pes. Known forms European.

Genera *Zanclodon*, ? *Teratosaurus*.

(3) Family *Amphisauridæ*. Vertebræ biconcave. Pubes rod-like; five digits in manus and three in pes.

Genera *Amphisaurus* (*Megadactylus*), ? *Bathygnathus*, ? *Clepsysaurus*; and in Europe, *Palæosaurus*, *Thecodontosaurus*.

(4) Family *Labrosauridæ*. Anterior vertebræ strongly opisthocœlian, and cavernous. Metatarsals much elongated. Pubes slender, with anterior margins united.

Genus *Labrosaurus*.

Sub-Order CŒLURIA (hollow tail).

(5) Family *Cœluridæ*. Bones of skeleton pneumatic or hollow. Anterior cervical vertebræ opisthocœlian, remainder bi-concave. Metatarsals very long and slender.

Genus *Cœlurus*.

Sub-Order COMPSOGNATHA.

(6) Family *Compsognathidæ*. Anterior vertebræ opisthocœlian. Three functional digits in manus and pes. Ischia with long symphysis on median line. Only known specimen European.

Genus *Compsognathus*.

DINOSAURIA?

(5.) Order HALLOPODA (leaping foot).—Carnivorous?

Feet digitigrade, unguiculate; three digits in pes; metatarsals greatly elongated; calcaneum much produced backward. Fore limbs very small. Vertebræ and limb bones hollow. Vertebræ biconcave.

Family *Hallopodidæ*.

Genus *Hallopus*.

The five orders defined above, which I had previously established for the reception of the American Jurassic Dinosaurs, appear to be all natural groups, well marked in general from each other. The European Dinosaurs from deposits of corresponding age fall readily into the same divisions, and, in some cases, admirably supplement the series indicated by the American forms. The more important remains from other formations in this country and in Europe, so far as their characters have been made out, may likewise be referred with tolerable certainty to the same orders.

The three orders of Herbivorous Dinosaurs, although widely different in their typical forms, show, as might be expected, indications of approximation in some of their aberrant genera. The *Sauropoda*, for example, with *Atlantosaurus* and *Brontosaurus*, of gigantic size, for their most characteristic members, have in *Morosaurus* a branch leading toward the *Stegosauria*. The latter order, likewise, although its type genus is in many respects the most strongly marked division of the Dinosaurs, has its

Scelidosaurus, a form with some features pointing strongly towards the *Ornithopoda*.

The Carnivorous *Dinosauria* now best known may all be placed at present in a single order, and this is widely separated from those that include the herbivorous forms. The two sub-orders defined include very aberrant forms, which show many points of resemblance to Mesozoic birds. Among the more fragmentary remains belonging in this order, but not included in the present classification, this resemblance appears to be carried much farther.

The order *Hallopoda*, which I have here referred to the *Dinosauria*, with doubt, differs from all the known members of that group in having the hind feet specially adapted for leaping, the metatarsals being half as long as the tibia, and the calcaneum produced far backward. This difference in the tarsus, however, is not greater than may be found in a single order of Mammals, and is no more than might be expected in a sub-class of Reptiles.

Among the families included in the present classification, I have retained three named by Huxley (*Scelidosauridæ*, *Iguanodontidæ*, and *Megalosauridæ*),[1] although their limits as here defined are somewhat different from those first given. The sub-order *Compsognatha*, also, was established by that author in the same memoir, which contains all the more important facts then known in regard to the *Dinosauria*. With the exception of the *Hadrosauridæ*, named by Cope, the other families above described were established by the writer.

The *Amphisauridæ* and the *Zanclodontidæ*, the most generalised families of the *Dinosauria*, are only known from the Trias. The genus *Dystrophæus*, referred provisionally to the *Sauropoda*, is likewise from deposits of that age. The typical genera, however, of all the orders and sub-orders are Jurassic forms, and on these especially the present classification is based. The *Hadrosauridæ* are the only family confined to the Cretaceous. Above this formation, there appears to be at present no satisfactory evidence of the existence of any *Dinosauria*.

[1] Quarterly Journal Geological Society of London, vol. xxvi. p. 34. 1870.

THE TAY AND THE FORTH BRIDGES

THE reconstruction of the Tay Bridge (if it really go on) by Mr. W. H. Barlow and the re-designing of the Forth Bridge by Mr. John Fowler and Mr. B. Baker will undoubtedly mark a new point of departure in the practice of British engineers. With the advent of railways there arose a generation of engineers who for some inexplicable reason ignored the traditions of their predecessors and gave no thought to wind pressure. Previous to this the question was always considered of vital importance by constructors. For example, Tredgold, writing some sixty years ago about roofs over building slips, directed special attention to the fact that such structures were "much exposed to be racked and strained by high winds," and recommended certain proportions, based upon the assumption of the actual weight of the roof being 16 lbs. per square foot, and the pressure of the wind 40 lbs. per foot. He thus clearly warned engineers that in some instances the pressure of the wind and not the load governs the strength of the structure. Nevertheless so completely have British engineers ignored this condition that it may safely be said at least three-fourths of the railway bridges in Great Britain and Ireland have no lateral bracing or provision of any kind to enable them to resist wind pressure. Even metallic arched bridges, which from their form must, in the absence of cross bracing, be necessarily in a state of more or less unstable equilibrium, form no exception to the rule. At Richmond, for instance, and at Kingston also, there are cast-iron arches about 100 feet in span, the lateral stability of which is dependent solely upon the 8 inches or 10 inches wide flanges of the arched ribs. There is no lateral bracing nor are there any iron cross-girders to bind the arched ribs together, and the lateral stiffness of a 10-inch flange over a span of 100 feet is more easily imagined than calculated. Within a few hundred yards of the Richmond Bridge is an anemometer which, according to the official returns, has not infrequently recorded a pressure of 27 lbs. per square foot, but it is hardly necessary to say that no wind pressure even approximating to that amount could ever have taken effect on the bridge.

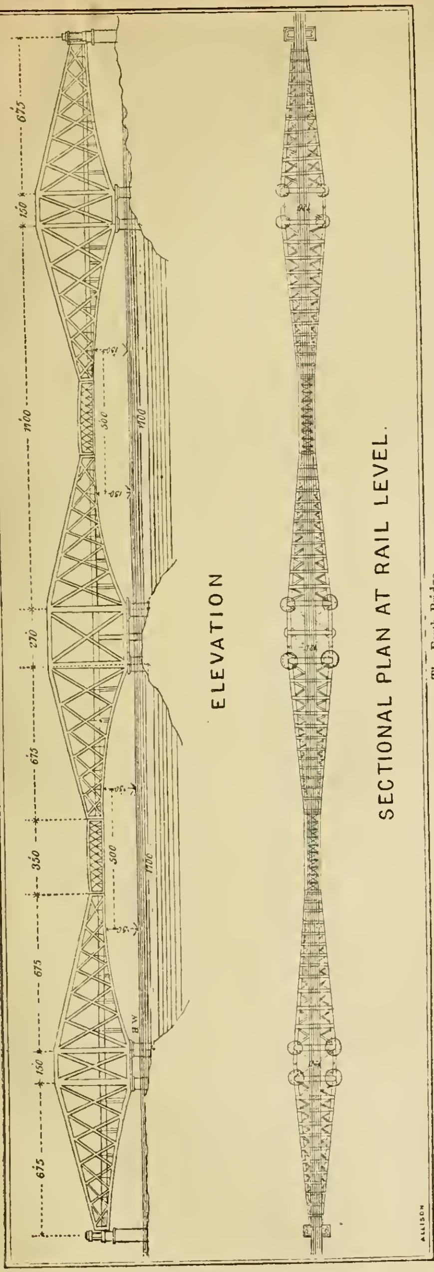
Since the fall of the Tay Bridge the principles and practice of Telford's day have been reverted to by British engineers, and the question of wind pressure has been most influential in determining the design and proportions of the new Tay and the proposed Forth Bridges.

In the original Tay Bridge the type of pier foundation finally developed was, it may be remembered, a single cylinder of 31 feet diameter. This was satisfactory enough as regards vertical pressure, but in the new design it was lateral and not vertical pressure which governed the form of the pier's foundation, and the latter will consist not of a single 31 feet cylinder but of two 23 feet cylinders spread 32 feet apart centre to centre, and affording correspondingly increased lateral stability. Similarly, as regards the metallic piers resting on these foundations: originally these consisted of a group of cast iron columns, and as regards vertical pressure nothing could be better, for, as we have recently ascertained by tests, a hollow cast-iron column of ordinary proportions will carry more load than either a wrought iron or a steel tube of equal weight. When the bending action of the wind upon a bridge pier is taken into consideration, however, the steady vertical pressure due to the load becomes of comparatively little moment, and Mr. Barlow has very properly adopted wrought iron for the piers of the new Tay Bridge, and the Board of Trade have with no less propriety intimated, in their recent "Memorandum of Requirements," that piers made up of a group of small cast-iron columns will no longer be passed by the inspecting officers.

The superstructure of the new Tay Bridge, no less than the piers, affords evidence of the provision which it is now thought necessary to make against the consequences of high wind pressures. Thus Mr. Barlow has provided three lines of defence against a train being hurled into the Tay, firstly, a guard balk of considerable height outside each rail; secondly, a ballasted floor of sufficient strength to hold up a derailed locomotive at any point; and thirdly, a strong iron parapet. Most of these provisions will in all probability be insisted upon by the Board of Trade in future railway bridges.

Turning now to the gigantic Forth Bridge, the influence of wind pressure in determining the design is beyond all precedent. The assumed lateral pressure of the wind upon the 1700 feet span girder is in fact no less than 50 per cent. greater than the maximum rolling load, so that were it not for the influence of gravity on the mass of the bridge, the required strength would be greater laterally than vertically to the extent of one-half. The weight of steel in the 1700 feet girder is, however, so considerable, that the stresses both for rolling load and wind pressure are relatively less than in smaller bridges.

The original design for the Forth Bridge by Sir Thomas Bouch was, it will be remembered, on the suspension principle. Except as regards the enormous drop in the suspension chains and the consequent unprecedented height of the piers, there was little to distinguish the proposed structure from an ordinary suspension bridge with stiffening girder, and without the inclined stays characteristic of American suspension bridges. During the past forty years the suspension principle has been universally rejected by engineers of all countries as unsuitable to the conditions of high-speed railway traffic, and the only reason for introducing it in the case of the Forth Bridge was the assumption that no other plan was commercially



The Forth Bridge.

attainable. It caused no little surprise therefore, and not a few expressions of incredulity, when Messrs. Fowler and Baker announced that the span of 1700 feet was no reason at all for departing from the old and well-tested principle of girder construction, but that on the contrary a girder bridge of proper design would be not only infinitely stiffer, but also considerably cheaper, than a structure on the suspension principle. This conclusion was however confirmed by Mr. W. H. Barlow and Mr. T. E. Harrison after careful independent investigation, and a design was finally agreed upon by all the engineers and accepted by the four railway companies finding the funds for its construction.

The Forth Bridge as intended to be constructed may be briefly described as a continuous steel girder bridge, of varying depth and with fixed points of contrary flexure. In several essential points it is analogous to the well-known continuous tubular girder bridge across the Menai Straits, as in both cases the continuous girder traverses two main spans and two end spans of about half the width of the former. In the Forth Bridge, however, the main spans are 1700 feet, and the end spans 675 feet, whilst in the Britannia Bridge the respective dimensions are but 460 feet and 230 feet. It is hardly necessary to say, therefore, that though the principle is the same the proportions and general details of the two structures present no points of resemblance.

The continuous girders of the Forth Bridge are 340 feet, or one-fifth of the span, in depth at the piers, and only 45 feet deep at the centre of the 1700 feet span. In ordinary continuous girders the points of contrary flexure are situated about one-fifth of the span from the piers, but in the Forth Bridge they are fixed at the most economical distance, which was found on investigation to be about two-fifths. Every continuous girder may, for purpose of calculation, be regarded as made up of a central girder supported by two cantilevers. In ordinary cases the central girder will have an effective span about equal to the total span $\div \sqrt{3}$. If the Forth Bridge were an ordinary continuous girder the effective span of the central girder would thus be about 982 feet, but as a matter of fact it will be made 350 feet, and it is to this deviation from the ordinary proportions that the economy of the design is largely due. By keeping the central girder of moderate span, or in other words by removing the points of contrary flexure farther from the piers, the central portion of the girder is lightened, the bending moment correspondingly reduced, and the mass of metal is concentrated near the piers, where it acts with the least leverage. Thus the lower member of the great girder, where it springs from the masonry piers at a height of 20 feet above high water, is a steel tube 12 feet diameter and about 2 inches thick, whilst at the centre of the span, where the bottom member has been cambered upwards to a height of 150 feet for navigation purposes, it is of ordinary trough section, about 3 feet in width.

On plan as well as in elevation the Forth Bridge is a continuous girder of varying depth. To resist high wind pressures the tubular lower members are spaced 120 feet apart, centre to centre at the piers, whereas the trough lower members of the central girder are spaced but 27 feet apart. By varying the effective depth of the girder both on plan and elevation a great saving is effected in the bracing, as the shearing stresses are to a large extent taken up by the main members of the girder. In a bow-string girder the bracing is similarly lightened by the arching of the top member. There are other sources of economy in the proposed design which we have not space to refer to at present.

It is intended, we understand, to give such proportions to the several members of the structure that under the combined stresses resulting from the maximum rolling load and a wind pressure of 56 lbs. per square foot, the stress per square inch will in no case exceed one-

fourth of the ultimate strength of the steel used in construction. The steel used in compression will be considerably stronger and harder than the more ductile material used for the parts in tension.

Facility of erection has necessarily been one of the most important governing elements in the design of the Forth Bridge. With 200 feet depth of water, scaffolding is of course out of the question, and the only practicable way of erecting the great girders is by commencing the work at each pier and adding successive bays of struts, ties, and bracing on either side, until the whole structure is complete. This mode of erection, technically known as "erection by overhang," is that which has been successfully adopted in the two largest railway bridges yet constructed, namely, the St. Louis Bridge across the Mississippi, of 525 feet span, and the Douro Bridge, of the same span, near Lisbon. The great advantage and security of erection by overhang in a case like the Forth Bridge is that every piece of the work is finished and securely braced against storms before another length is commenced. When the bridge is partially finished it will at the distance present much the appearance of three huge birds perched with outspread wings on as many rocks. The distance between the tips of the wings will be represented by that between the ends of the cantilevers, or say, 1500 feet. It might be thought that this would be a critical stage of the erection, but it is not so, as the work is so designed that if a hurricane of 56 lbs. per square foot were to strike one wing whilst the other remained becalmed the cantilevers would not spin round like a weathercock, but remain perfectly stable and secure.

We understand that the Board of Trade have signified their approval of the design and of the provisions made by the engineers as regards strains and wind pressures.

NOTES

THE last work of the late Mr. H. C. Watson on the distribution of British plants was his "Topographical Botany," published in 1873-4, in which he traced the dispersion of each species through the 112 vice-counties of Britain which he adopted. Of this book only 100 copies were printed for private circulation, and these were all given away by the author immediately. Since its issue a large amount of new material has been accumulated, principally through the exertions of the members of the Botanical Record Club, and at the time of his death, last autumn, Mr. Watson was engaged in the preparation of a new edition. This he did not live to complete as regards its prefatory and explanatory portions, but he had kept an interleaved copy in which he regularly entered up every record of any plant in a new district that was brought to his notice. At his own special request this was deposited with his herbarium at Kew, and from this it is now proposed to prepare a second edition of the book, which Mr. Quaritch has undertaken to publish, and Mr. J. G. Baker, of the Royal Gardens, and the Rev. W. W. Newbould to make ready for the press.

THE New York *Nation* announces the death of Mr. Lewis H. Morgan at Rochester, N.Y., on December 17, after a brief illness following a long period of delicate health. "With reference to our pre-Columbian antiquities," the *Nation* states, "he might for some time past have been called the Nestor of Indian ethnologists. A native of Western New York, he early became interested in the neighbouring remnant of the once mighty Six Nations, and gained a thorough insight into the political and military constitution of the Confederacy, its manners and customs, and above all its curious system of tribal intermarriages. Together with some kindred inquiring spirits he instituted, at the age of twenty-five, an Order, or 'New Confederacy' of the Iroquois—a sort of antiquarian society, having as a subsidiary aim the promotion of a kindlier feeling toward the red man; and before its 'councils' in the years 1844, 5, and 6, he read a number of papers on the Iroquois, which, under the *nom de plume* of 'Skenandoah,' were published, as letters addressed to Albert Gallatin, in Cotton's *American Quarterly Review*, in 1847. From this source they were reprinted by Neville B. Craig, of Pittsburgh, in his monthly *Olden Time* (1848), and five years ago once more saw the light in Robert Clarke and Co.'s reprint of the latter periodical. This work at once put Mr. Morgan in the front rank of Indian authorities. A professional visit to Lake Superior led him to observe an animal closely associated with the aborigines, and toward the close of 1867 he produced the 'American Beaver and his Works,' an exhaustive but highly readable monograph, in which, to use the words of the late Jeffries Wyman (*Nation*, February 27, 1868), Mr. Morgan, 'with a zeal and patience worthy of Réaumur, the Hubers, or of Darwin, re-examined the whole subject and largely increased our knowledge,' and which 'justly entitled him to an honourable place in the higher ranks of original observers.' The year following, in an article on the 'Seven Cities of Cibola,' in the *North American Review* (April, 1869), he struck a blow at the whole fabric of the theory of Indian civilisation handed down by the Spaniards and embalmed by Prescott, and laid the foundations of the prevailing conception of the meaning of that communal architecture which was for centuries regarded as royal and palatial. In 1873 appeared among the Smithsonian Institution's Contributions to Science a quarto volume of 700 pages, entitled 'Systems of Consanguinity and Affinity of the Human Family.' This was the first fruit of Mr. Morgan's discovery, while on his excursion to Lake Superior, that the system of marriage and relationship in the Six Nations was that of the American Indians generally, and his subsequent reflection that he had encountered a fundamental fact in the development of human society. He afterward resumed the whole question in a popular manner in his 'Ancient Society; or, Researches in the Line of Human Progress of Savagery through Barbarism into Civilisation.' His last work was among the pueblos of New Mexico, from the study of which he concluded that the Mound-builders were village Indians of New Mexican origin, and that the mounds were the platforms for their long wooden communal houses. These conclusions were published in the first report of the Archæological Institute of America (1880). On his death-bed he received his very latest printed work, 'Houses and House Life of the American Aborigines,' published by the Bureau of Ethnology of the Smithsonian Institution."

WE regret to announce the death, at the age of seventy-one years, of Prof. J. W. Draper, of New York. We hope next week to give some account of his varied work in science. The death of Mr. Binney, of Manchester, is also announced, and of him also next week we shall give a brief memoir.

THE scientific circle in Dublin has sustained a great and a deeply felt loss by the sudden and premature death of Dr. Reuben J. Harvey. Reuben J. Harvey was born in 1845; he was the son of a well known physician in Cork, still living, and for many years one of the most distinguished professors in the Queen's College of that city. He entered Trinity College, Dublin, in 1863, obtaining a non-foundation scholarship in science in 1866; he graduated as a senior gold medallist (Mathematical Tripos) in 1867. Entering the medical school of the University of Dublin he obtained the first medical scholarship in 1868, and graduated as M.B. in 1870. He completed his studies in the schools of Vienna and Würzburg; at one time he was a demonstrator in anatomy in the Dublin University School; of late years he was Professor of Physiology in the Carmichael School of Medicine, and one of the physicians of the Cork Street Fever Hospital. In the pursuit of his professional duties he was taken ill of typhus fever on the 24th of December last, of which he died on the 28th of the same month. His sterling qualities

endeared him to a host of friends; his mathematical abilities were of no common order, he was a painstaking and enthusiastic worker in the school of modern physiology, but it is to be feared that the results of much of his labour will now never be known, for he was slow to publish, preferring to wait for a completer confirmation of his numerous observations. He was an extremely popular lecturer, and his sudden death has saddened many a heart.

MR. A. G. MORE, F.L.S., M.R.I.A., &c., has been appointed to the post of Curator of the Dublin Natural History Museum. Mr. More is known to botany as the author (with the late Dr. Moore) of the "Cybele Hibernica." During the past fifteen years he has been principal assistant under the late curator, Dr. Carte. The published works of Mr. More are a "Natural History of the Isle of Wight," a supplement to Dr. Bromfield's "Flora Vectensis," an essay on "The Distribution of British Birds during the Breeding Season," the "Cybele Hibernica" and its "appendix," and numerous detached papers on natural history.

WE are glad to learn from Dr. Lindemann, of the Geographische Gesellschaft in Bremen, that the brothers Krause were sent by the Society to explore the Behring Straits regions, *not* for commercial purposes. MM. Krause are naturalists, and have no other object than to make observations and collections in natural history and ethnology. Their reports on their studies on the Chukchi Peninsula, which will be published with charts and woodcuts in the next numbers of the *Journal* of the Bremen Society, will prove that their voyage was not at all unsuccessful. They are now on their way from San Francisco to Sitka, and intend to winter on a station of the North-West Trading Company.

M. A. HÜNTER, who has spent twenty years in the exploration of the flora and fauna of the Onega region, discusses (*Memoirs* of the St. Petersburg Society of Naturalists, vol. xi.) the interesting question as to the natural boundary between Finland and Northern Russia, which had already been raised by Wirtzen, Bonsdorf, Malmgren, and Nylander. M. Hünter arrives at the same conclusions as most of the above-named explorers, namely, that all the region west of Lake Onega to the Gulf of Bothnia, and as far as the White Sea to the north must be considered as a part of Finland, Lake Onega being a marked boundary between the two regions as to their geological structure, topographical features, fauna, and flora. The flora west of this lake is far richer than east of it, and does not contain plants which are common to the latter region and higher latitudes. The list of plants of the whole of the Onega region contains 578 Angiospermæ, 5 Gymnospermæ, and 36 Cryptogams.

MESSRS. TAYLOR AND FRANCIS have issued a useful Tide-Table for 1882, in the form of a large wall-card. The Table is compiled by Mr. E. Roberts, of the Nautical Almanac Office, and contains the time of high-water at London Bridge, and the depths on the silt of the Shadwell lower entrance of the London Docks, showing also in a conspicuous manner the possible overflows. The table is likely to prove useful to many people, and we trust Mr. Roberts will be encouraged to continue it yearly.

THE Geographical Society of Paris received, at its last meeting, a communication sent from Lieut. Rogozinsky, of the Russian Imperial Navy, who proposes to explore the region between the Congo, the southern borders of Adaman, and the Cameroon Mountains.

A SCIENTIFIC Commission has been appointed by the Préfet of the Seine to determine the measures which ought to be taken immediately for the protection of the public in theatres. All of them which will not comply immediately with the provisions of the law will be closed. Two of them have been already proclaimed so. A sharp discussion took place in the Municipal Council, and it was proposed by influential members that the electric incandescent light should be deemed obligatory for all the municipal theatres.

THE Council of the Meteorological Society have determined upon holding an Exhibition of Anemometers at the Institution of Civil Engineers, 25, Great George Street, on the evening of March 15 next. The Committee are anxious to obtain as large a collection as possible of various patterns of anemometers, either full size, models, photographs, or drawings. Special interest will attach to all apparatus bearing upon the history of anemometers and to their modification and improvement. The Committee will also be glad to show any new meteorological apparatus invented and first constructed since the last Exhibition.

THE French exploring party who went to Fouta Djalon in the Niger Country, has arrived in Paris with a deputation from the sovereign of that land who has entered into a treaty with them. This is an important step towards the opening of Timbuctoo to trading caravans.

WITH the January number of the London Missionary Society's *Chronicle* is issued a sketch-map of South-Eastern New Guinea, in which are included the discoveries recently made by their agents, Messrs. Chalmers, Macfarlane, and Beswick.

AT Leghorn an interesting geological discovery has been made. The brothers Orlando have found a well-preserved skeleton of an *Elephas antiquus*; it was lying at a depth of about 4 metres below sea-level. Prof. Meneghini, of Pisa, superintended the excavation, and announces that the tusks are pretty straight and have the enormous length of nearly 4 metres.

AT Nordrup, near Ringsted (Denmark), an interesting discovery has been made. At a depth of only a few feet in a deposit of pumice-stone the remains of seven human bodies were found, together with numerous bronze objects, urns, gold rings, Roman glasses, mosaics, glass beads, &c. A similar discovery was made at the same spot some years ago.

THE "Year-Book of Photography" for 1882, edited by Mr. Baden Pritchard, contains a great deal of information that must be useful to those interested in photography. It contains a fine portrait of the late Mungo Ponton. Piper and Carter are the publishers.

WE have received the first part of a new monthly German journal of science—*Humboldt*—devoted to natural science generally. The contents are very varied and the style on the whole popular, with many illustrations. There is a long list given of eminent contributors. Enke, of Stuttgart, is the publisher.

ON May 15 next an exhibition of minerals and objects illustrating ceramics and the manufacture of glass will be opened at Madrid.

A SPECIAL despatch has been received at St. Petersburg from M. Sullowsky, dated Irkutsk, December 26 (O.S.) 1881, which says: "At 10 o'clock on the morning of August 9 I parted with the *William Rodgers*, which shaped her course for Herald Island. The clipper *Strelok* then returned to the Chinese ports. Up to that time the *Strelok* and *William Rodgers* had kept company. They were joined in Providence Bay by an American schooner, having on board the captain of a whaler which had stranded. This captain narrated that he had seen a boat with dead men on board which had been driven upon Herald Island. The boat also contained, besides other articles, some silver spoons with the name *Jeannette* engraved on them. In consequence of this narrative the captain of the *William Rodgers* resolved to proceed to Herald Island with the view of wintering

there, and, with the aid of dogs purchased in Kamschatka, sending out his crew in small parties to the various sides of the island and its vicinity to search for the lost explorers."

THE Geographical Society have issued (through Stanford) the first part, of seven sheets, of the large-scale map of East Central Africa, by Mr. E. G. Ravenstein, which we have referred to as in preparation. The map is on the scale of fifteen miles to an inch, extends from 10° N. to 20° S. and lat. of 25°. It thus includes an extensive area of great interest, and is on a scale to show all the leading features in detail so far as they have been discovered. Mr. Ravenstein has collected in his map a vast amount of information which could be obtained only by consulting many books, so that it will form a library in itself. The routes of all explorers are shown, and abundant notes are laid down as to the nature of the country, ethnology, doubtful points, &c. It gives evidence of conscientious, painstaking, and wide research. To all interested in marking the progress of African exploration it will prove of great utility.

ADMIRAL MOUCHEZ will give his usual annual *soirée* at the Paris Observatory in March. He has distributed to the leading Parisian engineering firms the conditions for the construction of the cupola for the great equatorial to be built in the newly-annexed grounds. The diameter of the revolving cupola is to be 20 metres. The form must be hemispherical. The time required for rapid revolution is 10 minutes. It is to revolve in the same direction as the heavens, and the mechanism will cause the revolution of a seat for two astronomers. The dimensions of the moving platform are 1 metre by 2. The competitors are to employ either a falling weight or a gas engine as motor. In this case the motor must be placed at a distance outside.

THE French Government is busy preparing a large number of new bills which will be laid before both Houses when the Parliamentary recess is over. One of these relates to the the use of the surplus gained by the Electrical Exhibition and the other to the telegraphic network.

PROF. J. G. MCKENDRICK, the new Fullerian Professor of Physiology at the Royal Institute, will give the first of a course of eleven lectures on the Mechanism of the Senses on Tuesday next (January 17); Mr. H. N. Moseley will give the first of a course of four lectures on Corals on Thursday (January 19); and Prof. E. Pauer will give the first of a course of four lectures on Ludwig van Beethoven (with musical illustrations) on Saturday (January 21). The first Friday evening discourse will be given by Dr. Huggins, on Comets, on January 20.

To the *British Trade Journal* for January, Dr. James Geikie contributes an interesting article on "The Gulf Stream and the Panama Canal," in which he concludes that the opening of the Canal "will have as much effect on the Gulf-Stream and the climate of Northern Europe as the emptying of a teapot-ful of boiling water into the Arctic Ocean would have in raising the annual temperature of Greenland."

AMONG the sixpenny popular editions issued by Messrs. Longman and Co. is an abridgement of the Rev. J. G. Wood's "Homes Without Hands," under the title of "Strange Dwellings; being a Description of the Habitation of Animals."

THE Austrian Minister for Public Instruction has ordered a colossal statue of the late Austrian Arctic explorer and discoverer of Franz-Josef Land, Carl Weyprecht. The statue will be executed by the celebrated sculptor, Victor Tilgner, of Vienna, in Laas marble.

M. PAUL BERT has filled an important lacuna in the organisation of the French system of public instruction in Algiers. He has authorised the École Supérieure of Letters in Algiers to grant honours in Arabic literature, after candidates have passed through a special examination.

RUSSIAN papers state that on December 22, 1881, at 11.20 p.m., a meteor, spreading an intense violet light and the fall of which was accompanied by a strong explosion, was seen at Byejetsk, in the government of Tver, and at the village Nasilovo, twenty-seven miles distant from that town.

THE detailed report of Prof. Sorokin to the Kazan University on the downs of Kara-koum in Russian Turkestan, has appeared in Russian as a separate volume, under the title of "Travel in Central Asia in 1878-79."

A SHOCK of earthquake was felt at Batoum (Caucasus) on December 28, 1881, at 6.33 p.m. It lasted for about ten seconds, and was accompanied by a loud underground noise.

EXPERIMENTS in the culture of the Chinese Soja bean (*Soja hispida*), which gave good results in Vienna when Prof. Haberlandt made use of seeds received from Northern China and Mongolia, have been repeated in Russia, and so far have been quite successful in Kieff, Saratoff, and the Crimea, but they have failed in the western provinces of Russia.

ON December 22, 1881, Tiflis was covered with a sheet of snow ten inches deep. Snow is a very rare occurrence in this town, and its appearance seems the more strange as there has been no snow in all Central Russia.

A VALUABLE discovery has been made in a quarry at Dillingen, near Saarlouis. Some workmen found in a small cavity a bronze vessel containing gold and silver ornaments of partly beautiful and partly very coarse workmanship. Amongst them is a golden disc of 8 centimetres in diameter richly covered with rubies, emeralds, and filigree work; also a silver object weighing over 150 grammes, and bearing inscriptions in Latin, Greek, and unknown characters. The proprietor of the quarry will present the objects found to the Bavarian National Museum.

NEAR Caltanisetta, Sicily, a series of caverns have been discovered, which are evidently burial-places dating from the period when the ancient Sicilians had already been ousted by the Italian tribes, but before the Greek colonisation had begun. Their arrangement is similar to the tombs at Pantelica, Acri, and Girgenti. In the neighbourhood of the caverns are numerous remains of ancient buildings and other proofs of the existence of an ancient populous colony. The spot derives its name from the hill of Gibil Gaib.

PHYLLOXERA seems to have abandoned the vineyards of Lombardy and Liguria, but has appeared in other parts of Italy, viz. Elba, Sardinia, &c. In Sicily the plague is making rapid progress; the districts of Messina and Caltanisetta being particularly unfortunate.

M. SYNGROS, the Athens banker who gave 100,000 francs for the erection of an archæological museum at Olympia, has again given a like sum to facilitate the progress of the work.

AN earthquake is reported from Honolulu on September 30, 1881. It consisted of one very violent and two lighter shocks. The first was felt at 4.53 a.m. lasting thirty seconds, and accompanied by loud subterranean rumbling; direction south-east to north-west. The crater of Kilauea was very active at the same time. Numerous houses were more or less injured. The phenomenon was also observed on all the other islands of the Hawaiian Archipelago. An earthquake is also reported from Eastern Galizia on December 29, 1881; several shocks lasting a few seconds. A sharp and unusually sustained shock of earthquake passed along the east coast of India on the morning of the 31st

ult. At Calcutta it lasted about two minutes. It was especially severe in Madras, where, judging from the space devoted to it by the local papers, it would appear to have caused much alarm. No damage is, however, reported.

THE English representative of the company which manufactures the Griscom motors, mentioned in our article last week, writes us to the effect that the small form of motor there described will attain a speed of 3000 revolutions per minute when worked with a 6 cell bichromate battery, and will accomplish 1000 foot-pounds of work per minute; and that with a dynamo-current this limit is far exceeded. We are also informed that the Company has established a branch in London for the direct supply of their motors to the public.

DR. WOEIKOFF asks us to correct an error in the abstract of his paper on the freezing on a salt lake (NATURE, vol. xxv. p. 206). It is there stated that "it was never observed before in laboratories that salt water was cooled below $-4°$ without being frozen, and here we have salt water remaining unfrozen at $-13°$ below zero." In the paper referred to Dr. Woeikoff simply stated that temperatures below $-4°$ C. were not before observed in saline solutions outside of laboratories, while here we have temperatures of $-13°$ observed in a salt lake.

THE additions to the Zoological Society's Gardens during the past week include a Crab-eating Raccoon (*Procyon cancrivorus*) from South America, presented by Mr. H. B. Whitmarsh; two Pileated Jays (*Cyanocorax pileatus*) from La Plata, presented by Mr. C. S. Barnes; two Lesser Black-backed Gulls (*Larus fuscus*), British, presented by Mrs. Brindley; a Speckled Terrapin (*Clemmys guttata*) from Massachusetts, three Confluent Rattlesnakes (*Crotalus confluentus*) from Dakota, U.S., presented by Mr. W. A. Forbes, F.Z.S.; a Blue-eyed Cockatoo (*Cacatua opthalmica*) from the Solomon Islands, a Short-eared Owl (*Asio brachyotus*), British, deposited; six Grey Squirrels (*Sciurus cinereus* var. *nigra*) from North America, purchased; a Gayal (*Bibos frontalis*), born in the Gardens.

THE SWISS SEISMOLOGICAL COMMISSION

THE Seismological Commission of Switzerland, after having published in French and German an excellent text-book on earthquakes, by Prof. A. Heim, and after having widely circulated its queries on earthquakes, has received a great mass of information which is mentioned in high terms both as to their accuracy and interest. Prof. A. Heim, availing himself of this material, has already published in the *Annuaire* of the Physical Observatory at Bern, an interesting monograph on the earthquakes of last year, and now M. Forel, of Morges, also publishes in the *Archives des Sciences Naturelles* of Geneva a first paper on earthquakes for the first thirteen months of the existence of the Commission from December, 1879, to January, 1881. We see, from a list of earthquakes during the years 1876 to 1880, which he publishes, that there were in Switzerland during this period of time, no less than forty-eight earthquakes, of which twenty-five were in 1880, the Commission having received accurate information on twenty-one of them, and four feeble shocks more having been reported in newspapers, but they still are rather doubtful. This increase of earthquakes in 1880 must, however, be to a certain degree the result of more accurate observation since the appointment of a special Commission for that purpose. The chief earthquakes during these thirteen months—December, 1879, to January, 1880—were the following:—On December 4 and 5, 1879, consisting of three main shocks and of seven feebler ones. The first and the third of the main shocks had each an extent of about 100 miles, and the aggregate area shaken by these earthquakes had a length of 250 miles and a width of 40 miles, its longer axis being parallel to the main chain of the Alps; the centres of the successive shocks advanced from south-west to north-east.

The earthquake of December 29 to 31, 1879, had a great extension. To use M. Forel's expression, "this beautiful earthquake" consisted of three chief shocks and of a dozen smaller ones. The first strong shock was experienced on an area limited by Lyons, Locle, Solothurn, Luzern, Sion, Chamonix, and Annecy, affording thus an ellipse 200 miles long and 100 miles wide, the great axis of which also was parallel to the main chain of the Alps. Its centre was between the Arve and Drarse Rivers, and its intensity at Geneva reached seven degrees of the decimal scale proposed by M. Forel. The shock propagated itself by several oscillations, at a speed of 300 to 400 metres per second. The following main shocks had a smaller area, but the centre did not advance along the axis of the shaken area; it remained in the neighbourhood of Geneva. It is rather remarkable that at the same moment as Savoy and Western Switzerland experienced this earthquake, another series of feeble shocks was felt at Niederaach in Thurgau, both earthquakes being separated by a zone 160 miles wide, where no shocks were observed.

The earthquake of July 3 to 5, 1880, extended throughout the whole of Switzerland, reaching also the southern parts of the Grand Duchy of Baden and Northern Piemont, and shaking an area 203 miles long and 187 miles wide. It was much complicated, two strong shocks having been felt almost in all Switzerland, whilst many other feebler shocks, about twenty in number, which preceded and followed the main ones, had a merely local extension. Prof. Heim shows that in this earthquake there was no central point from which the shocks might have been transmitted in all directions; and he thinks therefore that there was a general dislocation of strata on a very wide surface, rather than any shock departing from any determined point of the territory.

After further details, M. Forel tries to classify the earthquakes with relation to the seasons, and to the position of the moon; but we will not follow him in these researches, as he himself states that a thirteen months' period of observations is too short a time for such generalisations. But we may notice the circumstance that, whilst in some earthquakes the shock is propagated from a centre to the circumference, in others all the surface of the country seems to be pushed in one general direction; Prof. Heim discovers this character in the earthquakes of December 5, 1879, and of July 4, 1880. The importance of this remark will not escape the attention of those who are engaged in the study of the formation of mountain ridges.

It is obvious that the Commission met with several difficulties in performing their task, and the chief are in the notation of the time of the earthquake and of its direction. Humanity seems to be, even in the fatherland of clockwork, very far from knowing the true time, and even the clocks of the towns, of the railway and telegraph stations, seem to leave very much to desire as to the accuracy of the information they give us. Some improvement, however, is shown in that direction during this last year, and it may happen that the desire of making accurate observations on earthquakes will give an impulse to some improvement in our knowledge of time. As to the direction of earthquakes, there are yet more difficulties, and M. Forel points out the interesting circumstance that nearly all information as to the direction of earthquakes is influenced by the orientation of streets, the direction of earthquakes nearly always being given either parallel or perpendicular to the observer's street. On some occasions, as in the earthquake of July 28, 1881, everything on the surface of the soil seems to be in a vibratory motion, as grains of sand on the surface of a vibrating slab, and the shocks are observed in all possible directions as well vertical as horizontal.

But it is not only from Switzerland that the Seismical Commission has received valuable information, and we find in the *Archives* two interesting papers on the earthquakes of the island of Chio, by M. Arland, and on those in Asia Minor, by M. van Lennep. As to the former, we notice that the volcanic eruptions on the island of Nisyros had ceased a month before the catastrophe, and that they have not begun again up to the present. The oscillations of April 3 seem to have had an amplitude of 15 degrees, and from April 3 to April 7, there were counted no less than 250 shocks, of which 30 to 40 were very strong. On April 11, at 7 p.m., there were the well-known great shocks which occasioned such a panic. They continued until the month of August, being followed by a standstill from August 1 to August 25. On this day and the following there were again strong shocks. From a complete list of houses destroyed, published by M. Arland, we see that there were no less than 6730, and that the number of killed and wounded was, in various villages, as much as 10 to 30, and even 36 per cent. of the population. M. Arland gives also some interesting notices as to the direction of the shocks in Calimassia, and to the disturbances they have done to the walls of the houses.

SOLAR PHYSICS[1]

III.

YOU will recollect that in my last lecture I explained to you the special absorptions that were due to certain hydrocarbons. To-day I wish to tell you some of the applications that can be made from an investigation and examination of this series. Before I proceed farther I wish to show you not only that there are absorptions which are due to the vibration of the atoms of these hydro carbon molecules, but also that there is a general absorption which seems due to the molecular vibration of these same hydro-carbons.

I wish to point out to you the general absorptions of the first three of those spectra, the alcohol series. The first one is methyl alcohol which has a light molecule, or rather, I may say that it is lighter than the molecule of the next, common alcohol which in its turn again is lighter than propyl alcohol. You will see that the general absorption creeps up from the ultra-red towards the red. In each case the lighter the molecule the more vigorous is the general absorption. I was obliged to refer to this, because through the course of my lecture you will see that this has an important bearing on some of the results which we got.

Another point is the effect of heat upon this general absorption; and here I speak with a certain amount of diffidence. My belief is that the general absorption is increased by an increase of temperature in the hydro-carbons, in water, or in any of those liquids which we examined. Thus, with water, we find that the general absorption creeps up, the hotter the water is. In fact, at this time of the year when the temperature is high, it is very hard indeed to get some of those special absorptions very far down in the ultra-red, because they are blocked out, as it were, by the general absorption which is due to the vibrating molecules—molecules of course vibrating in the manner which I have described.

The hydro-carbons which we have examined were all in the liquid state, and it seems very probable—nay, more than probable—almost certain,—that if you were to convert those liquid hydro-carbons into gas you would get their absorptions in the same localities. For instance, in the diagram (Fig. 14) I will

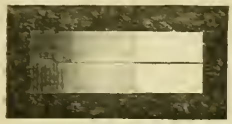


FIG. 14.—Absorption spectra of liquid and gaseous bromine.

show you the absorption spectrum of bromine. The top spectrum is the absorption spectrum of liquid bromine, and the bottom spectrum is the spectrum of gaseous bromine. You will see that the difference between the two is that, where you have the general absorption in the liquid, it is split up into lines in the case of the vapour. Thus in the case of the liquid we have the blue end of the spectrum entirely cut off by a general absorption gradually increasing from the blue to the green. When we pass to the gaseous bromine we have the same absorption but terminated with bands. I do not say that this is always the case in bodies which have the same chemical constituents.

Now, so far having cleared the ground for our next point, I must refer you back to the map of the infra-red of the solar spectrum which I alluded to last time. After we had completed our map of the ultra-red absorption spectra of these different hydro-carbons, we had the curiosity to look at the map of the solar spectrum to see whether we could discover anything at all in relation between the two. Col. Festing and myself were very surprised to find that we had mapped lines identical with lines in the ultra-red region of the solar spectrum. Thus, for instance, when we looked at the spectrum of water—we found that one line lay in the little *a* group, and had a wave length of 833. When we examined chloroform, we also found that it had a great many lines which we suspect are to be found in the solar spectrum. We then went to ethyl iodide, and here we also found coincidences; but the coincidences were more marked than in the former case. For instance, last time I told you that, in order to identify the base or radical band of any particular hydro-carbon, it was necessary to look for the base or radical, and, if need be, to confirm it by looking at other bands which were situated somewhere about the little *a* in the solar spectrum. In the case of ethyl iodide we found that the band about little *a* coincided with part of the band in the solar spectrum. We also found that all of the alcohol series had one strong line coincident with a solar line; other lines were also to be found coincident with other lines of the solar spectrum. Furthermore the relative intensities of the lines in the liquid and solar absorption spectra seemed identical.

What, then, was the conclusion which we had to draw from this? It was that the lines in the solar spectrum must have something to do, or must have some connection at all events, with the lines found in the hydro-carbon series.

Now, as I have said, where you have a liquid you need not expect the spectrum to be so minutely covered with lines as you would if you had the body in the gaseous state, and, in all probability, suppose that we could have ethyl iodide in a gaseous state which is a thing not impossible to have—(it is very easy, only it is difficult to get enough of it)—those radical bands would probably split up into fine lines, and from the preliminary experiments which we have made it seems as if that would really be the case. But as this of course is a work of only a few months old, this requires confirmation; and Col. Festing and myself propose to carry out with vapour what we have already carried out with liquids. In our own minds there is no doubt that some at least of the hydro carbons we have examined, are to be found in the solar spectrum, and we are also inclined to think that the hydro-carbons are not combined with oxygen, because, were they combined with oxygen, we should expect to find a more complicated spectrum of these particular lines or bands in the solar spectrum.

Now suppose that we have such a compound as an ethyl compound of some description in the solar spectrum. Where can such a compound exist? It must exist in one of two places. It must exist near the sun, or it must exist in our own atmosphere. Now the nearer you go to the sun of course the hotter the region, and it is quite impossible that these hydro-carbons, whatever they may be, should exist very near to the solar disc or to the nucleus. But if they do exist in the solar atmosphere at all they must exist at some little distance from them in a cooler region. You will recollect that Mr. Lockyer pointed out very clearly that there are regions around the solar nucleus which have vastly different temperatures.

Now the question is, what compounds could exist even at a comparatively low temperature. There is a gaseous body allied to the ethyl series which would have the same radical or base bands, namely, acetylene. Acetylene can exist at a high temperature; it has been found in the cooler part of the arc of the electric light, but we also know that three of its molecules will combine to form benzine. Let us see what we should get, suppose that we have a ring of this hydro-carbon outside the sun; and then let us see what evidence would prove the presence of this hydro-carbon. I have here a small diagram showing what we

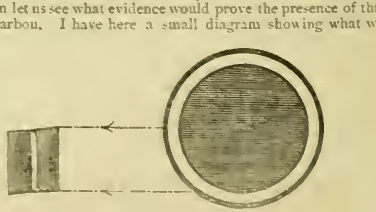


FIG. 15.—Solar disc surrounded with a hydrocarbon ring.

might expect to see. The black disc is supposed to be the solar nucleus, and this black ring which you see round it is supposed to be the ring of a hydro-carbon. The slit of the spectroscope is also shown. Now, if it exists at some little distance from the solar nucleus, you will see that when the light passes from the edge of the sun through that ring and then through the slit of the spectroscope, it will pass through a deeper layer of matter than it would supposing the light came from the centre. In some photographs I took of the solar spectrum some time ago, before we made these experiments, I found that some of the lines were more broadened at the limb of the sun than were other lines; and these lines apparently are coincident with these hydro carbon lines. So, you see, from an examination of the hydro-carbons and an exam-

[1] Lecture delivered on May 25, 1881, at the Lecture Theatre, South Kensington Museum, by Capt. Abney, R.E., F.R.S. Continued from p. 191.

ination of the sun's limb, we may be able to form an idea as to whether such hydro-carbons are present in the atmosphere of the sun. Of course, as I said before, this work is new and will require a great deal of confirmation before it can be put forward as an absolute certainty. Mr. Lockyer suggested another way in which this broadening of the lines of the limb might arise. Supposing the corona were to be composed of hydro-carbon, and also supposing we got a streamlet or streamer of the corona lying in the same line to the earth as the limb of the sun; then we should get exactly the same result. Studying the diagrams, it is quite evident that if it were composed of hydro-carbon we might get a thickening of the hydro-carbon lines at the limb, because it would pass through a greater quantity of matter than at the centre.

Secondly, these hydro-carbons might exist in our atmosphere; but then if they did exist there, there is a very easy way of

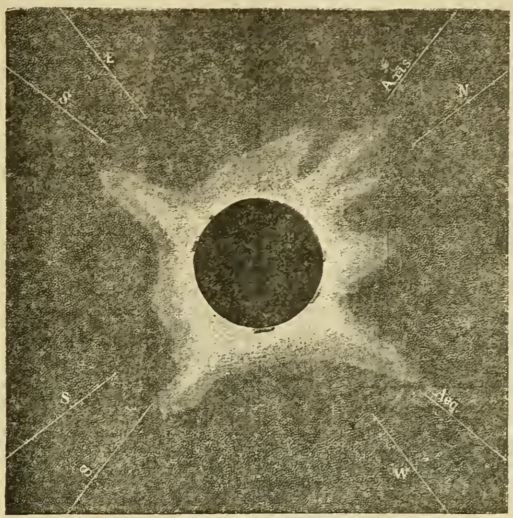


Fig. 16.—Solar corona, as seen during an eclipse.

proving whether such is the case. If we photograph the solar spectrum when the sun is very high in the heavens, and photograph it also when the sun is very low, we pass through a very much larger quantity of atmosphere in the second case than we do in the first case. Now I have never noticed that there has been any particular absorption with a low sun, except, it may be perhaps, a greater general absorption on the more refrangible side of the dark Z line. But this, of course, like the rest of the work, requires still further examination, and I am only, as it were, throwing out hints as to the work that will have to be done in this particular region.

But now about aqueous vapour. In 1860 Brewster and Gladstone published a map of the spectrum, showing atmospheric absorption, and this investigation was continued by an eminent French physicist, M. Janssen, in 1864. Brewster and Gladstone had shown that certain lines were due to atmospheric absorption; and Janssen went farther and tried to confirm their researches, or to correct them. He lit a bonfire near Geneva, and observed the spectrum of the bonfire thirteen miles off, and found that there were a great many lines in the spectrum when he observed it thirteen miles off, which were not present when he observed it near; and these could only be due to atmospheric absorption. But that did not settle the point whether the lines that he noticed were due to the air or to aqueous vapour. In order to ascertain which lines were due to aqueous vapour, in 1860, he filled an iron cylinder 330 feet long with steam, and then observed the absorption spectrum of steam through this great length of tube, and he noted that certain lines were visible in the spectrum which were also visible in the spectrum which he obtained by viewing the bonfire thirteen miles off. As a further confirmation, he appealed to the stars. He observed Sirius, for instance, at a high altitude, and also at a lower altitude, and found that there was a darkening of some of the Fraunhoferic lines. Whether this was due to aqueous

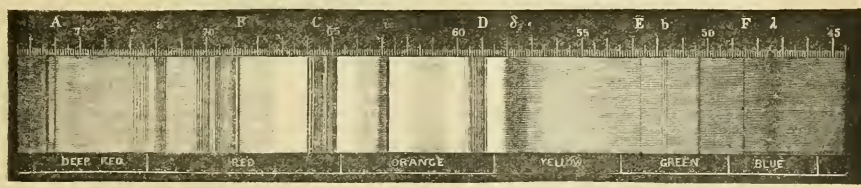


Fig. 17.—Angström's map, showing telluric lines.

vapour or to the air lines, of course could only be settled by reference to the absorption spectrum which he obtained from viewing a candle flame through the 330 feet of aqueous vapour. That distinguished man, Ångström also examined into the subject, and in his map are shown the lines which he considered to be due to the atmosphere.

Now from very careful examination, he considered that neither the A line nor the B line was due to aqueous vapour, but he thought they might be due to carbonic acid. From what we have observed, it seems highly probable that they are not due to carbonic acid because, if we had a compound of carbon and oxygen, we should not expect to see such a spectrum at all. I think that from the context we shall see a great probability as to what they may be due. Other observers observed the spectrum of the atmospheric lines, but perhaps the most recent and trustworthy observer is Prof. Piazzi Smyth. He published in the "Edinburgh Astronomical Observations," vol. xiv., a memoir regarding these black lines. Regarding B he says that they are merely dry air lines, and that the A line is a solar line. I should like to quote his own words with regard to this particular A line. He says, "The remarkable clearness, plainness, and strength of the lines composing A and its parallel bands in a high sun tend to claim the said A and its appendages a solar line, and, if so, it is a grander one by far than any other solar line in the whole of the solar spectrum. If, on the other hand, some observers will claim A as only a gas effect, Ångström has said that

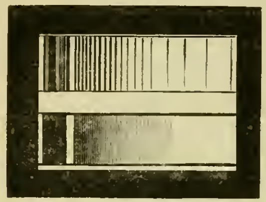


Fig. 18.—Top spectrum the A line; bottom spectrum the benzine radical band.

A grows or reinforces at sunset. I may say that I have seen it this summer (1877) in Edinburgh almost at the point of sunset, and ascertained with a more powerful prism, that, though heavily black as it was, it hardly was in reality grown at all." He says that the time was too short for him to measure absolutely the number of lines, but his impression was that the number of lines composing the A band was not diminished at all, and that the A line presents the same appearance at sunset as it did in a high sun.

Now, as I said at the beginning of my lecture, we must take into consideration the general absorption which is always more or less visible in the spectrum, and at sunset we always have greater general absorption than we have of course when the sun is at midday, because the stratum of air between us and the sun is greater in the one case than it is in the other. Smyth, I believe, supposed that the A line was due to hydro-carbon, and I should like to show you that, probably, his surmise is correct. [I subsequently found that this idea did not originate with the Professor.] An examination will show you how very remarkably like the A group of lines is, to this B group of lines. They both have a band—a common band which, with a very high magnifying power, is splits up into fine lines. From analogy, one would suppose, then, that the A and B lines are due to the same substance. If one looks at the A line with a small dispersion, one sees it very much of the same form as the benzine radical band that you saw (Fig. 18). It appears to have a dark distinct band, and then to shade off for some considerable distance. Now the remarkable thing about this is that if I transferred this A line such as we see here to about a thousand wave lengths down the spectrum, we should get the characteristic radical band of benzine. In our comparison of the solar spectrum with that of benzine we have found unmistakable proofs of the existence of benzine in the solar atmosphere. This being the case, the big A line and the benzine, or the benzine series may have some connection one with the other; and it seems to me from analogy that sooner or later the A line will be found to be due to a hydro-carbon of some kind. You recollect in the photograph I showed you last time, that as the molecule got lighter the radical band went up towards the blue. Now the benzine has essentially a comparatively speaking heavy molecule. It is composed of 6 of hydrogen and 6 of carbon, and therefore if we can examine a hydro-carbon, which has the same proportions of hydrogen to carbon, but of a different molecular grouping, I think it extremely probable that eventually we shall find that the A line belongs to that particular group of the hydrocarbons in which there are equal atoms of hydrogen and carbon. As to the B line the question is, can the B line, which has a similar look to the A line be due to a hydro-carbon. That requires great consideration. Every observer, I believe, has put B down as an atmospheric line, and therefore if such be the case we shall have to look for a hydro-carbon high up in our atmosphere.

Now, to come back, what would be the effect of aqueous vapour? First of all, we should have a general absorption in the ultra red part of the spectrum, and then also a special absorption. The annexed diagram (Fig. 19) is from a photograph of the solar spectrum taken through various thicknesses of water, and you will see what kind of effect the various thicknesses have upon absorption

This bottom figure is the spectrum through three feet of water. The next part of the spectrum is photographed through one foot of water; and the next part of the spectrum is photographed through six inches of water. You will see what a remarkably little absorption there is of the visible spectrum due to a certain amount of water. Now, can water have the same effect as aqueous vapour? I think it can. If M. Janssen had condensed the steam in the 330 feet tube, and only had a thickness of somewhere about three inches of water to look through, then looking through three inches of water he would have seen no absorption whatever. In other words, where you have a liquid converted into a vapour a given weight of it seems to absorb a great deal more as vapour than it does as liquid. Sometimes we see this even in the visible part of the spectrum.

When you have a cold north-east wind, you have an atmosphere very free from moisture, and you are able to go down in the infra red regions very far; but when you have a change of

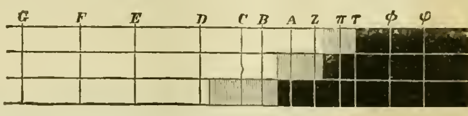


Fig. 19.—Absorption spectra of different thicknesses of water.

weather and a south-west wind, for instance, you have a remarkable absorption setting in, and you have the limits of the solar spectrum ending somewhere about τ, and you may try your utmost and yet on one of these days you will not be able to go one jot farther than that particular line. In other words, the general absorption due to atmospheric water in some form or another comes in, and not special absorption.

In the diagram, Fig. 7 (see p. 188), we have two bands, ϕ and ψ, at the extreme right of the ultra red, and only on two days in two years have I ever been able to obtain a photograph of those particular bands. They were obtained in both cases in March, and it was when the air was particularly free from aqueous vapours, and it was very cold. To sum up, where you have a west wind, or a south-west wind and high temperature, a general absorption takes place in the ultra part of the spectrum. It is only when you have very cold air, with a north-east wind or dry wind, that you are able to get even as far down as we have got.

The next point to which I wish to call your attention is, Is it probable that in the ultra red part of the spectrum we should ever be able to obtain evidences of metallic lines, or lines which are due to metallic vapours? I think that it is highly improbable that we shall. The few metals that we have tried have given almost a negative result except in one or two cases. Thus in looking through the list of lines due to the metallic elements, there are very few that go even as far as 700 in the scale of wave-lengths.

They generally end somewhere about 650 wave lengths. Of course there is one well known exception, which is the potassium line, which has the wave-length of 770 (in fact below the A line), and is visible with a certain amount of difficulty. But as a rule all the bright metallic lines end above 700, and when they get towards 700 they are always thin lines and poor lines. When you come to think of it, it seems highly improbable that you should obtain lines very low down except in the case of metals of low fusing point. If you have a metal of low fusing point, of course it is much more likely that you get lines of low refrangibility than you would if the metals have a high fusing point, and as a fact, taking a metal which has got a high fusing point such as iron, you find no line in the ultra red part of the spectrum, whereas in the case of sodium, which has a low fusing point, we do find a pair of solitary lines about W L 840.

When you heat platinum wire by a current of electricity, at first though it may be hot to touch, it remains dark. Then, as you increase the current, it gets red and hotter still, and new waves —green—put in an appearance; and finally we get white light. At 550 degrees centigrade the body shows redness. At a white heat we have the whole of the visible spectrum present. Whether all the waves exist at ordinary temperatures in the platinum wire is a matter for future consideration. It is, I think, possible that such may be the case, provided the amplitude be very small indeed. At all events, the molecules of the body on which the source of radiation falls must be in a state ready to vibrate with the higher wave-length. Each wave as it puts in its appearance has a certain amount of energy, and a comparison between the energy of the two waves may be shown by photography as well as by their heating effect. But the heating effect is the true comparative measure of energy if the body on which it falls completely absorbs the radiations. Lamp black, perhaps, is the most perfect absorbent of all radiations, and the energy is shown by the heating effect on it. This heating effect in its turn is converted into an electric current by the use of a thermo-pile. Here is a thermo-pile which is capable of movement by a screw in any required direction, and we will take a very brilliant spectrum and cast it upon its face. It is connected with the galvanometor, and the galvanometer reflects a spot of light on this scale, and when a current passes that spot of light is deflected. You will see whereabouts it is. Now if I move the face of the pile gradually into the yellow I think you will find that it will move slightly up the scale. We will bring it more into the red, and if the galvanometer is in order you will see that it ought to be deflected still more. We have now got it in the infra-red part of the spectrum. The deflection is still greater.

It was by noting the deflections in somewhat this way that Dr. Tyndall was able to construct his spectrum monogram of the electric light, using as his material prism rock salt. The limit of the red is shown by an arrow, on the left is the thermogram of the visible part of the spectrum, and on the right of the invisible part of the spectrum (Fig. 20). Now this thermogram

Fig. 20.—Tyndall's thermogram of the spectrum of the electric light.

is a puzzle, or rather was a puzzle, in a great many ways. For instance, if you know the wave-length of any two points you may find the theoretical limit of the spectrum by the method which I showed you in my last lecture. Unfortunately it lies well within the heat curve, or rather the effect of heat which is shown in the diagram.

When working it out in this way it will be found that what I may call the thin tail of the thermogram lies beyond the theoretical limit of the spectrum. But before I go any farther I want to show you a possible cause for this. This rock salt prism has been very finely polished by an optician, and I will mount it in the place of the bi-sulphide of carbon prism which we have so far employed. Now rock salt is supposed to allow the low radiations to pass through much more readily than a glass prism. We will try to get the spectrum tolerably pure. You will see that there is a fairly bright spectrum upon a piece of card.

Now in making observations with rock salt prisms, Col. Festing and myself were rather mortified to find that we got beyond the limits of the spectrum when employing photography.

Our curiosity was therefore raised, and we endeavoured to find out why this was the case. We therefore placed some bichromate of solution of potash in front of the slit of the spectroscope and observed the spectrum. I will repeat the experiment, and you see that all round the spectrum we have a wide spreading yellow halo which is due to the imperfection in the rock salt. The rock salt surfaces are as perfect as grinding can make them, but still there is a certain amount of diffused light which passes irregularly through the prism, and gives us that yellow halo. It is totally different as you will notice when you replace the bi-sulphide prism in position. You get a pure spectrum. You will see that each side the green and the red is tolerably sharp, and when you use a properly adjusted spectroscope the perfections, and for that matter the imperfections, are much more apparent than they are when making a lecture-table experiment. I have shown you this experiment that you may see with what caution measurements taken with rock salt should be received. I may say that we tried not only one prism but three or four, made out of different samples of rock salt, and all gave a like result. The only way we can use a rock salt prism when it is well ground is to allow an excessively narrow beam of light to pass through it. Directly any large surface of the prism (as is the case when a lantern, or condensing lens for condensing the beam upon the slit), is used, the action of diffused light at once renders the results liable to suspicion.

Now I will show you other figures obtained from a thermo-pile when using very delicate apparatus. I wish to show you how the thermo-pile and photography can work hand in hand. We have a thermogram taken with a glass prism, and you will see that it presents some features of similarity—not quite like Tyndall's thermogram. There is a reason for this difference, which is that the one is a thermogram of the positive pole of a powerful electric light, whereas I believe the other was

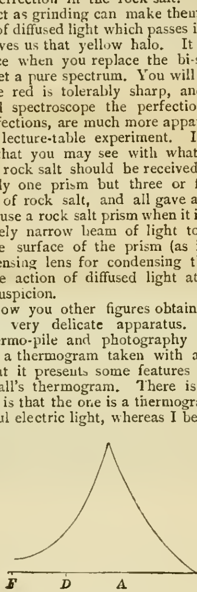


Fig. 21.—Thermogram of the spectrum, the positive pole of the electric light.

taken with the whole of the radiation coming from both of the poles and from a less powerful electric light. The negative pole of the light we used has been calculated to have approximately a temperature of 3,000°, whilst the positive pole approximately a temperature of about 4,000°. When using a source of one temperature, and that temperature of about 4,000°, you will see that the curve forms a cusp, that is at the place of maximum heating effect it comes very nearly to a point, and I believe that if we obtained a spectrum of a source of heat at a perfectly

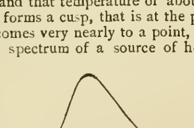


Fig. 22.—Energy curve of the same spectrum as Fig. 21, obtained by means of photography.

even temperature we should get that thermogram with an absolutely sharp point. By taking photographs we are able to check the results of the thermo-pile.

Fig. 22 is an energy curve as depicted by a photograph. You

see it does not come to nearly such a sharp point as when a thermo-pile is used, and you ask why. The reason is that at that particular part the bromide of silver—blue bromide—does not entirely absorb the radiations, but allows a certain amount to pass through. Nevertheless you will see that there is a striking similarity between the two.

Now I wish to show you how you may combine the thermographs of two or more temperatures. I must, first of all, show

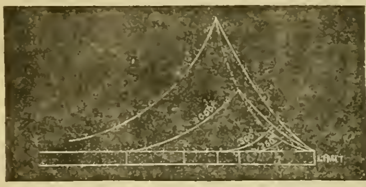


Fig. 23.

you the thermographs of varying temperatures (Fig. 23). We have a temperature of 250°. Next we have a temperature of 500°; next 2,000, next 4,000.

In diagram (Fig. 24) we have a combination between the thermograms of two temperatures, one of about 2,000°, and the other of about 4,000°. By measuring the height of these curves

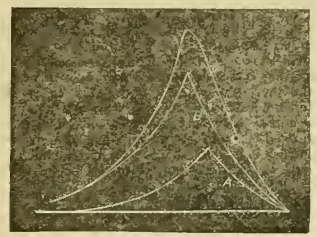


Fig. 24.—Combination thermogram.

and taking the mean you get the central curve. You should compare this with Prof. Tyndall's curve. You see it is not very different from the curve taken from the combination of the two curves. My time, however, is drawing to a close, and I am obliged to go but shortly through this part.

In my last lecture I showed you how the diffraction spectrum was spread out in the infra-red in comparison with the prismatic spectrum, and I think that it may interest you here to show you the way in which a thermogram of the solar spectrum is spread out when the prismatic thermograph is altered into a refraction thermograph or thermogram.

In Fig. 26 I give a diagram of a solar prismatic spectral thermogram (Fig. 25) as obtained by Lamarsky spread out into a diffraction curve. You see that instead of the maximum heating effect of the solar spectrum being beyond the red, it lies well between E and D. In other words the maximum energy of the solar spectrum lies in the yellow and not in the ultra red as has usually been considered.

The energy of a wave, or a series of waves, is measured by the square of the amplitude divided by the square of the wave length into a constant. The area of wave section is equal to the amplitude—that is to say the height of the wave multiplied by the length of the wave into a constant. If these waves have equal sectional areas, the energy varies inversely as the fourth power of the wave length. And what I wish to draw your attention to is this—that starting from the theoretical limit of the prismatic spectrum to the maximum heating effect of any continuous spectrum a law seems to hold that the energy of any portion of the spectrum below its point of maximum energy does vary inversely as the fourth power of the wave length.

I am sorry I have not time to go farther into the detail of this, but it has been the result of some considerable calculation, and experiment.

After my last lecture I was asked whether the photograph taken by the kettle in the manner explained was not due to the heat rays. I am afraid my reply was somewhat short as I said, "There are no such things as heat rays." I think that now may be an opportunity in which to express my views on the subject in a less curt manner than that in which I answered my questioner. It is true that we often do hear of dark heat rays and of radiant heat, and the rays which are principally concerned in the latter definition are taken to lie in the infra-red region of the spectrum. I would ask, "Why give them a name to which, it seems to me, exception can be justly taken?" In 1800, Sir William Herschel proved that these dark rays could be refracted

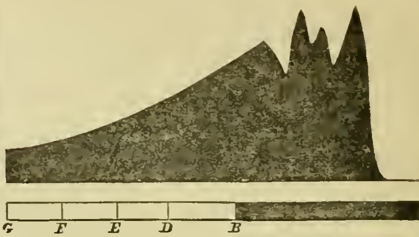


Fig. 25.—Prismatic thermogram of solar spectrum obtained by Lamansky.

and reflected like those rays which, falling on our retina, give us the sensation of colour. Professor Forbes, in his celebrated experiments, proved the same thing; but, in addition, he likewise proved that they could be polarised. I think I have laid before you proofs that these same rays can expend their energy in chemical action causing a disruption of a molecule by their successive impacts. Those rays, by whose agency we see, exercise the same functions as these dark rays. All rays are alike, and whether they cause a rise in temperature, or cause a chemical decomposition of a body, depends solely on the nature of that body on which they fall. The waves, as I have tried to demonstrate, carry energy and nothing else; and they must meet with some obstruction which shall destroy their motion before they can show that they possess energy. The work done by them is

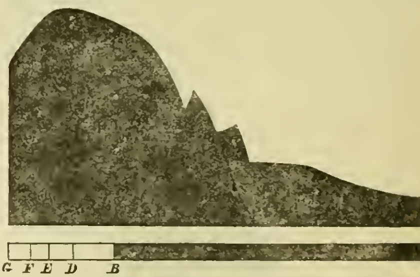


Fig. 26.—Diffraction thermogram from Fig. 25.

manifested by either molecular motion, or atomic motion, or both; the molecular motion of the body showing itself perhaps as heat, and the atomic motion as chemical action. If we must have the word "radiant" tacked on to a definition, (and the word "radiant" is a remnant of the corpuscular theory of heat,) all the wave motion in the ether should be classed under the head of "radiant energy." If a shorter nomenclature is required, let us simply call it "light," including in it the energy carried. Light is an old word understood in one sense by all, and we need only talk of the heating effect of light, and so on. The word "actinism" falls into an equal condemnation. We have unluckily none of our most eminent philosophers who are scientific photographists, if there were I do not believe any would defend the retention of the word "actinic" "or chemical rays" amongst

our scientific terms. In the expression actinism and radiant heat, the cause has been mixed up with the effect. To be consistent, given one class of bodies the rays falling on it should be called actinic rays; whilst, given another, they should be called heat rays.

In 1840 Dr. F. W. Draper, of New York, clearly pointed out the identity in quality (if I may so call it) of the light, heat, and actinic rays, and that identity, I hold, has been confirmed more than once by recent investigators. I speak, perhaps, somewhat strongly on this point as no one knows better than myself the immeasurable mischief which a wrong definition causes in the progress of a scientific education. Men matured in science can afford to use any definition since they can carefully guard it by mental reservations as to what they really understand by it; but I hold it as a misfortune of no mean order that definitions, which are not so exact as our present state of knowledge can make them, should be given to the uninitiated whose reasoning powers must at the outset be feeble. A definition containing but half a truth must of necessity lead a student of science to a wrong conclusion at some time or another. If our writers of text-books could but be persuaded to write as they believe in this matter, and as some have written (for instance, Clerk Maxwell), we should have fewer mistakes made in explaining the ordinary phenomena met with in daily life.

I think I have now explained what I meant when the answer was given, "There are no such things as heat rays:" a source of energy may be darkly hot as was the kettle, some of the energy radiating from it was expended in heating bodies round it, but that portion which radiated through the holes perforated in the card and which struck the plate was, at all events, partially expended in converting the silver bromide into the sub-bromide.

In the course of these lectures, which I now finish, it has been my endeavour to show you the principles on which experiment in the infra-red region has been carried out, and also to point out the necessity for further work of no light kind in this part of the spectrum. The preceding lectures will also have shown you that work is required to investigate the visible part of the spectrum, and also in the observation of the various phenomena presenting themselves on the solar surface which must of necessity react upon our earth. It has been ignorantly said that the study of solar physics will be exhausted in ten or twelve years, but from what you have heard my colleagues tell you it will surely last our lifetime. If I live till the exhaustion takes place, my allotted threescore and ten years will, I should say, be greatly overstepped. I prophesy, though it can hardly with decency be called a prophecy, that many generations will pass away before all is known of the exact relationship between solar and terrestrial phenomena. What we do know already is hardly the alphabet of the language in which the sun addresses us, and until that alphabet is mastered the whole story that he would tell us must remain undeciphered.

MORPHOLOGY OF THE TEMNOPLEURIDÆ

THE following is an abstract of a communication read before the Linnean Society, Dec. 15, 1881:—The Temnopleuridæ, a sub-family of oligopores, are remarkable for their sutural grooves and depressions at the angles of the plates. The author examined the grooves and depressions or pits in *Salmacis sulcata*, Agass, and found that these last are continued into the test as flask shaped cavities sometimes continuous at their bases which are close to the inside of the test, but do not perforate. This is the case in the median vertical sutures of the interradium and ambulacrum. Between the interradium and the poriferous plates of the ambulacra are numerous pits in vertical series which are the ends of cylinders closed and often curved within. Altogether the undermining is considerable. The grooves over the sutural margins are losses to the thickness of the test. The edges of the contiguous plates are sutured together, by a multitude of knobs and sockets $\frac{1}{800}$ of an inch in diameter visible with a hand lens. In the vertical sutures there is an alternate development of knobs and sockets on each plate corresponding to a similar development on the opposed plates. Between the horizontal plate edges are sutures remarkable in their distinctness and position. The apical edges of the interradial plates have multitudes of sockets and the actinal edges, knobs: whilst the apical edges of the ambulacral plates have knobs and the actinal have sockets. The ambulacra, on their interradial edge have nothing but knobs and the interradial plates corresponding sockets, so that a great series of knobs and socket "dowelling" prevails. *Temnopleurus torematicus*, Agass., gave similar results modified by the great development of the grooves and the young form was shown to differ from the adult, and to have rows of knobs and sockets, and barely penetrating pits. The arrangement in *Salmacis bicolor* and *Amblypneustes ovum* was considered. The pits have an importance for they increase the superficies of the derm and near the peristome, as indicated by Lovén, they contain *Sphæridia*.

The paucity of knowledge respecting the union of the plates of the Echinoidea was noticed and the nature of the suturing of Echinus and *Diadema* was explained, the first resembling part of that of a young *Temnopleurus*, but it was without knobs and sockets. The author concluded by separating the Temnopleuridæ into two divisions, those with pits and those with grooves without pits. The last are the oldest in time and resemble young modern forms which subsequently develop pits. He reduced the number of genera considerably.

P. M. DUNCAN

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

WE are glad to learn that the number of students who have entered the Chemical Laboratory of Firth College, Sheffield, this session, has been so great, that the present accommodation has been quite insufficient. The Council, therefore, decided at their last meeting to erect working benches for sixteen more students. The University of Edinburgh have recently recognised Dr. Carnelly, Professor of Chemistry in Firth College, as a Teacher of Medicine in Sheffield, whose lectures on Chemistry, and course of instruction in Practical Chemistry shall qualify for graduates in Medicine in that University. The lectures on Chemistry and Laboratory Practice at Firth College have also been recognised by the Royal College of Surgeons and the Royal College of Physicians.

SCIENTIFIC SERIALS

American Journal of Science, October, 1881.—Cause of the arid climate of the western portion of the United States, by C. E. Dutton.—Embryonic forms of trilobites from the primordial rocks of Troy, N.Y., by S. W. Ford.—Observations of comet *b*, 1881, by E. S. Holden.—Thickness of the ice sheet at any latitude, by W. J. McGee.—Notes on earthquakes, by C. G. Rockwood. Marine fauna occupying the outer banks off the southern coast of New England, by A. E. Verrill.—Note on the tail of comet *b* 1881, by L. Boss.—Geological relations of the limestone belts of Westchester Co. New York, by J. D. Dana.

November, 1881.—Jurassic birds and their allies, by O. C. Marsh.—The remarkable aurora of September 12-13, 1881, by J. M. Schæberle.—The stereoscope and vision by optic divergence, by W. L. Stevens.—The electrical resistance and the coefficient of expansion of incandescent platinum, by E. L. Nichols.—Local subsidence produced by an ice-sheet, by W. J. McGee.—Notes on the Laramie group of Southern New Mexico. by J. J. Stevenson.—Polariscopic observations of comet *c* 1881, by A. W. Wright.—The relative accuracy of different methods of determining the solar parallax, by W. Harkness.—The nature of Cyathophycus, by C. D. Walcott.

Journal of the Franklin Institute, December, 1881.—Report of the committee on the precautions to be taken to obviate the dangers that may arise from electric lighting.—Report of committee on fire-escapes and elevators.—Chemical methods for analysing rail steel, by M. Troilius.—Notes on the properties of dynamo-electric machines, by E. Thomson.—Blast-furnace hearths and linings, by J. Birkinbine.—Sand-filtration at Berlin, by W. R. Nichols.—Report of committee on Griscom's electric motor.—Weighing the sun by a soap-bubble, by P. E. Chase.

Bulletin de l'Académie Royale des Sciences de Belgique, Nos. 9 and 10.—*Apropos* of determination of latitude, by M. Folie.—On the origin of Devonian limestones of Belgium, by M. Dupont.—Application of accidental images (second note), by M. Plateau.—A means of measuring the flexure of telescopes, by M. Ronzean.—On the micaceous substance of veins of Nil St. Vincent, by M. Renard.—Reports, &c.

Archives des Sciences Physiques et Naturelles, December, 1881.—International Geological Congress of Bologna, September and

October, 1880, by M. Renevier.—Meteorological *résumé* of the year 1880 for Geneva and Great St. Bernard, by M. Plantamour.—Periodical movements of the ground indicated by the air-bubble of spirit-levels, by the same.—On the movements of the ground, by Col. von Orff.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti, vol. xiv., fasc. xvii.—On recent discoveries of Silurian fossils in the province of Udine, by M. E. T. Taramelli.—Synthesis of β methylpyridine (β picoline), by G. Zanoni.

SOCIETIES AND ACADEMIES

London

Royal Society, December 15, 1881.—"On the Electromotive Properties of the Leaf of Dioneæ in the Excited and Unexcited States." By J. Burdon Sanderson, M.D., F.R.S., &c. (Abstract.)

The paper consists of five parts. Part I. is occupied by the examination of two experimental researches, relating to the subject, which have been published in Germany since the date of the author's first communication to the Royal Society, namely, that of Prof. Munk on Dionæa, and of Dr. Kunkel on electromotive action in the living organs of plants. According to Dr. Munk, the electric properties of the leaf may be explained on the theory that each cylindrical cell of its parenchyma is an electromotor, of which the middle is, in the unexcited state, negative to the ends, and that on excitation the electromotive forces of the cells of the upper layer undergo diminution, those of the lower layer an increase. He accounts for the diphasic character of the electrical disturbance which follows mechanical excitation by attributing it to the opposite electromotive reactions of the two layers of cells. According to this theory, each cell resembles in its properties the muscle-cylinder ("Untersuchungen," vol. i. p. 682, 1848) of du Bois-Reymond, differing from it in so far that its poles are positive instead of being negative to its equatorial zone.

Dr. Kunkel's experiments have for their purpose to show that all the electromotive phenomena of plants may be explained as consequences of the movement of water in the organs at the surfaces of which they manifest themselves. Neither of these theories is consistent with the author's observations.

Part II. contains a description of the apparatus and methods used in the present investigation.

In Part III. are given the experimental results relating to the electromotive properties of the leaf in the unexcited state, a subject of which the discussion was deferred in the paper communicated by the author (with Mr. Page) in 1876.[1] The fundamental fact relating to the distribution of electrical tension on the surface of the leaf when in the unexcited state is found to be that (whatever may be the previous electrical relation between the two surfaces) the upper surface becomes, after one or two excitations, negative to the under, and remains so for some time. Under the conditions stated, this difference of potential between the two surfaces occurs constantly; the differences of potential which present themselves when other points of the surface of the leaf are compared, may be explained as derived from, or dependent on, it.

Part IV. relates to the immediate electrical results of excitation, *i.e.* to the electrical phenomena of the excitatory process. In investigating these the author takes, as the point of departure, an experiment which includes and serves to explain those obtained by other methods, and is therefore termed the "fundamental experiment." It consists in measuring the successive differences of potential which present themselves between two opposite points on the upper and on the under surface of one lobe of the leaf, during periods which precede, include, and follow the moment at which the opposite lobe is mechanically or electrically excited. In this experiment it is found that, provided that the conditions are favourable to the vigour of the leaf, the changes in the electrical relations of the two surfaces (called the excitatory variation) occur in the following order:—

Before excitation (particularly if the leaf has been previously excited).	*Upper* surface negative to under.
At the moment of excitation.	Sudden negativity of *under* surface, attaining its maximum in about half a second, the difference amounting to not less than $\frac{1}{18}$ Daniell.
After excitation.	Rapidly increasing negativity of the *upper* surface, beginning 1·5″, and culminating about 3″ after excitation, and slowly subsiding.

[1] "On the Mechanical Effects and on the Electrical Disturbance consequent on Excitation, &c.," *Proceedings*, December 14, 1876.

This subsidence is not complete, for, as has been said, the lasting difference between the two surfaces is augmented—the upper surface becoming more negative after each excitation ("after-effect").

When by a similar method two points are taken for comparison on opposite lobes, the phenomena are more complicated, but admit of being explained as resulting from the more simple case above stated, in which only a few strata of cells are interposed between the leading off electrodes.

In Part V. the relation of the leaf to different modes of excitation is investigated. As regards electrical excitation the results are as follows:—If a voltaic current is led across one lobe by non-polarisable electrodes applied to opposite surfaces (the other lobe being led off as in the fundamental experiment) a response (excitatory variation) occurs at the moment that the current is closed, provided that the strength of the current is adequate, and not much more than adequate. No response occurs at breaking the current. When a current of more than adequate strength is used, and its direction is downwards, the response at closing is followed by several others. This effect does not happen when the current is directed upwards. To evoke a response a current must be much stronger if directed upwards than if directed downwards through the same electrodes. Weak currents cease to act when their duration is reduced to $\frac{1}{100}$″; for stronger ones the limit is shorter. Inadequate currents, if directed downwards, produce negativity of the upper surface, which lasts for several seconds after the current is broken. This effect is limited to the surfaces through which the current is led. Its direction shows it is not dependent on polarisation. By opening induction-currents, if their strength does not much exceed the limit of adequacy, a leaf may be excited at intervals for several hours without failure. Weaker currents are more effectual when directed downwards than when directed upwards. If two inadequate induction-currents follow one another at any interval less than 0″·4 and greater than 0″·02, they may evoke a response. In this case a response follows the second excitation. When a leaf is subjected to a series of induction currents at short intervals ($\frac{1}{20}$″) the response occurs after a greater or less number of excitations. If the temperature is gradually diminished the number is increased by each diminution. All of the above statements relating to excitability refer to plants kept in a moist atmosphere at 32—35° C.

From the preceding facts and others which are stated in the paper, the author infers (1) that the difference observed between different parts of the surface of the leaf are the expressions of electromotive forces which have their seat in the living protoplasm of the parenchyma cells. (2) That the second phase of the excitatory variation is probably dependent on the diminution of turgor of the excited cells, and therefore on the migration of liquid; (3) but that no such explanation can possibly be accepted of the phenomena of the first phase, the time relations of which, particularly its sudden accession and rapid propagation, show it to be the analogue of the "negative variation" or "action current" of animal physiology.

Zoological Society, January 3.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. W. A. Forbes exhibited and made remarks on the horns of the Prong Buck (*Antilocapra americana*) lately shed by the specimen living in the Society's Gardens. This was, it is believed, the first instance on record of the same individual having shed its horns in captivity in two consecutive years.—A communication was read from Prof. Owen, C.B., on *Dinornis* (Part xxiii.), containing a description of *Dinornis parvus*, a new species of about the size of the Dodo, of which a very complete skeleton (now in the British Museum) had been lately discovered in a cavern in the province of Nelson, New Zealand.—A communication was read from M. L. Taczanowski, C.M.Z.S., containing an account of the birds collected by Mr. Stolzmann during his recent journey in North-Eastern Peru, with descriptions of some new species.—A communication was read from Mr. Martin Jacoby, containing the descriptions of three new genera and fourteen new species of Phytophagous Coleoptera from various localities.—Mr. Oldfield Thomas read a paper on the African Mungooses (*Herpestinæ*), in which he reduced the described species of this group to nineteen, divisible into seven genera.—The Rev. Canon Tristram read the descrip-

tion of a new species of Land-rail obtained at Ribè, East Africa, by Mr. R. C. Ramshaw, which was proposed to be named *Crex suahilensis*.—Mr. W. A. Forbes read a paper on the existence of a gall-bladder in, and on other points in the anatomy of, the Barbets and Toucans (*Capitonidæ*). The peculiar form of the gall-bladder in these birds, as well as other features in their myology now described for the first time, were stated to make the relationship of this group to the Woodpeckers (*Picidæ*) still more certain than it had previously been from the observations of Nitzsch, Kessler, Garrod, and others.

Meteorological Society, December 21, 1881.—Mr. G. J. Symons, F.R.S., President, in the chair.—The following were elected Fellows of the Society :—H. P. Bell, F. B. Edmonds, T. C. Evans, S. L. Fox, J. J. Gilbert, M. Henry, J. B. McCallum, J. Parry, and B. C. Wainwright.—The papers read were—The rainfall of Cherrapunji, by Prof. J. Eliot, M.A., F.M.S. Cherrapunji is notorious for its excessive rainfall, larger in amount it is believed, that any at other place, so far as is known. Cherrapunji is a small Indian station situated in the south-west of Assam, on a small plateau forming the summit of one of the spurs of the Khasia Hills. These hills rise on the south with exceeding abruptness, and have the Bengal plains and lowlands at their base. Cherrapunji stands on the summit of one of these hills, at an elevation of about 4100 feet. The hill on which it is situated rises precipitously from the lowlands of Cachar and Sylhet, which are barely 100 feet above sea-level. During the south-west monsoon the lower atmospheric current advancing across the coast of Bengal has a direction varying between south-south-west and south east in Lower and Central Bengal. In thus advancing almost directly towards the hills of Western Assam, the mountain ranges cause a very considerable deflection of the current ; one portion is forced upwards as an ascending current with a velocity directly dependent upon the strength of the current in the rear, and upon other conditions which need not be enumerated. The rapid diminution of temperature which accompanies expansion due to ascensional movement of air is usually followed by rapid condensation in the case of a moist current, such as the south-west monsoon current. The normal annual rainfall in Cachar and in the plains of Northern Bengal is about 100 inches. The average annual rainfall of Cherrapunji is 493 inches, that is, 393 inches in excess of that at the foot of the hills on which it is situated. The rainfall of Cherrapunji is not due to any abnormal local conditions of atmospheric pressure, air movement, &c., but simply and solely owing to the presence of a vast mechanical obstruction which converts horizontal air motion into vertical air motion.—On the meteorology of Cannes, France, by Dr. W. Marcet, F.R.S., F.M.S.. This is a discussion of the observations made at this celebrated health-resort during the six winter seasons ending 1880.—Report on the phenological observations, 1881, by the Rev. T. A. Preston, M.A., F.M.S.

Royal Microscopical Sociey, December 14, 1881.—Prof. P. Martin Duncan, F.R.S., president, in the chair.—Eight new Fellows were elected and nominated.—Mr. J. Deby exhibited his method of turning the correction-collar of objectives by a worm-wheel, acted upon by a tangent screw with a long arm, and Mr. Crisp exhibited Parkes' drawing-room microscope and two new homogeneous immersion fluids from Dr. van Heurck of Antwerp.—Mr. T. Charters White described a new growing slide devised by him, and Mr. Stephenson exhibited scales of *Machilis maritimus* and *Tomocerus plumbeus*, mounted in phosphorus under the binocular, with 1-25 inch objective, showing that the scales were plane on the under side and corrugated on the upper, a view which Mr. J. Beck controverted.—A note was read by Dr. Anthony on the statoblast of *Lophopus crystallinus* as a test for high powers.—Mr. Guimaraens exhibited the Echinorhynchus of *Lota vulgaris*, suggested to be a male specimen containing ova described as "dedans par hasard."—Mr. A. D. Michael read a paper, further notes on British *Oribatidæ*, which Prof. Huxley and others state to be wholly viviparous. He finds, however, that they are chiefly oviparous, as stated by Nicolet and others, and that the young are brought to maturity in at least four different modes ; (1) the egg is deposited in a slightly advanced stage, as in insects; (2) deposited with the larva almost fully formed ; (3) the female is occasionally viviparous (in these modes only one egg is usually ripe at a time) ; (4) several eggs are matured at once, but not deposited The mother dies, the contents of her body, except the eggs, dry up, and her chitinous exterior skeleton forms a protection throughout the winter to the eggs. The occurrence of a deutovium stage in the egg is recorded, *i.e.* the egg has a hard shell, which splits into two halves as the contents increase in volume, the lining membrane showing between, and gradually becoming the true exterior envelope of the egg.—Several new and interesting species were described and figured, and exhibited under microscopes, Mr. W. H. Symons also read a paper on a hot or cold stage for the microscope.

Geological Society, December 21, 1881.—Mr. R. Etheridge, F.R.S. president, in the chair.—Messrs. Charles Duffin Barstow and Joseph Lundy were elected Fellows, and Prof. E. D. Cope, of Philadelphia, a Foreign Correspondent of the Society.—The following communications were read :—The Torridon Sandstone in relation to the Ordovician rocks of the Northern Highlands, by Mr. C. Caliaway, M.A., D.Sc., F.G.S. —The Precambian (Archæan) rocks of Shropshire, part 2, by Mr. C. Callaway, D.Sc., F.G.S.—The red sands of the Arabian Desert, by Mr. J. A. Phillips, F.R.S., F.G.S. The author described the general characters of the Nefüd, of great red desert of Northern Arabia, which consists of a series of parallel ridges of considerable elevation, no doubt at some period piled up by the action of strong winds, but now no longer undergoing much change of position, as is evidenced by the fact that sticks and stones remain for many days uncovered on the surface, and that the landmarks made use of in crossing the desert appear to be permanent. A specimen of the sand of this desert received by the author from Lady Anne Blunt, is composed of well-rounded red grains from 1-50th to 1-30th of an inch in their longest diameter, which are rendered colourless by treatment with hydrochloric acid, the material thus removed amounting to ·21 per cent., or a little more than 1-500th of the total weight operated upon, and consisting of ferric oxide with a small quantity of alumina. The sand dried after the action of hydrochloric acid gave on analysis :—

Silica	98·53
Protoxide of iron	0·28
Alumina	0·88
Lime, magnesia, and alkalies	trace
	99·69

The external coating of ferric oxide must therefore have been deposited subsequently to the rounding of the grains ; it could not have been derived from an external decomposition of the grains themselves ; and it becomes difficult to imagine in what manner the superficial red coating can have been produced. The author compared these grains with those of the millet-seed sandstones of Triassic age, with which they closely agree in character, but remarked that the conditions of their occurrence were apparently quite different.—Analyses of five rocks from the Charnwood Forest district, by Mr. E. E. Berry, communicated, with notes, by Prof. T. G. Bonney, F.G.S., Sec. G.S.

EDINBURGH

Royal Society, December 19, 1881.—Mr. D. Milne Home, vice-president, in the chair.—The Makdougall Brisbane prize for the period 1878–80 was presented to Prof. Piazzi Smyth, Astronomer-Royal for Scotland, for his extremely valuable paper on "The Solar Spectrum in 1877-78."—Sir Robert Christison communicated a short paper on the application of the rocks of the great precipice of Ben Nevis to ornamental work, in which he drew attention to the little-known but most magnificent view of the great precipice from below, characterising it as the grandest in the whole island. From the various kinds of granitic and porphyritic rocks there found, all of which are susceptible of a high polish, he had got constructed a very graceful obelisk, which was shown to the Society.—Dr. D. J. Hamilton exhibited and described certain physical experiments bearing on the circulation of the blood-corpuscles, from which he explained many points hitherto unexplained. Thus the rapid gliding central motion of the coloured corpuscles, and the slower rotational peripheral motion of the colourless corpuscles were to be explained by the fact that the latter were specifically lighter than the blood plasma, while the former were of the same specific gravity as the fluid in which they were borne along. Such a physical difference was sufficient to explain the phenomenon ; and that such a difference existed could easily be demonstrated by observation as to the parts of a blood-vessel in which the colourless corpuscles abound. The second part of the paper dealt with more purely pathological questions, referring, for example, the migration of the blood corpuscles from the blood-

vessels into the surrounding tissues simply to the increase of fluid pressure caused by stasis, and not to the amœboid movements of the corpuscles, which are generally urged as the true cause. Dr. R. S. Marsden read a paper on the state of carbon in iron and steel, in which it was argued that the molten metal held the carbon in solution, and that, on cooling, the carbon crystallised out in minute diamond crystals, so giving to the metal its peculiar hardness and temper. Much would depend on the size and number of the crystals, and the size was obviously a function of the rate of cooling; so it was quite conceivable that too much, as well as too little, carbon might have a deleterious effect upon the physical properties of the metal.

Boston, U.S.A.

American Academy of Arts and Sciences, December 14, 1881.—Prof. J. Lovering, president, in the chair.—Prof. C. L. Jackson and Mr. A. E. Menke presented the results of an investigation upon curcumin. The formula was shown to be $C_{14}H_{14}O_4$. By the study of the potassium salts it was proved to be a diatomic monobasic acid. Powerful oxidising agents destroy it; weaker agents, not in excess, give vanillin, but in too small quantity for purification; by oxidising diethylcurcumin, however, with potassic permanganate the authors obtained ethylvanillic acid, with melting-point at 195°.—A paper on a comparison of the Harvard College Observatory Catalogue of Stars for 1875, with the fundamental systems of Auwers, Boss, Safford, and Newcomb, was read by Prof. William A. Rogers.—Dr. Wolcott Gibbs announced the discovery of the following new complex acids:—Arsenoso-molybdic acid, arsenoso-tungstic acid, antimonoso-molybdic acid, antimonoso-tungstic acid, vanadoso-molybdic acid, vanadoso-tungstic acid, vanadio-phosphoric acid, vanadio-arsenic acid, vanadio-antimonic acid. All of these acids have well defined series of salts.—A paper on the law of diffusion of gases was read by Mr. N. D. C. Hodges.

Paris

Academy of Sciences, January 2.—M. Jamin in the chair.—M. Blanchard was elected Vice-President for 1882.—The Academy has lost three members during 1881, viz. MM. Delesse, Deville, and Bouillaud; and two correspondents, MM. Kuhlmann and Pierre.—M. Faye presented the *Annuaire du Bureau des Longitudes* for 1882; it contains, *inter alia*, a complete table, with history, &c., of the comets of the last decade, by M. Lœwy, and a fac-simile of M. Janssen's photograph of the comet of last summer.—On the correction of compasses, and on M. Collet's recent "Treatise on the Regulation and the Compensation of the Compass," by M. Faye.—Craniology of the Mongolian and white races, by MM. de Quatrefages and Hamy. They presented the tenth and last volume of their "Crania Ethnica," and gave a *résumé* of the contents. The different general forms of the human skull are found in each of the three chief races; but while among the black races, globular skulls, and among the yellow, elongated skulls, are rare, among the white the two cephalic types coexist in nearly equal proportions. The authors regard craniology as one of the most powerful means of scientific study of human races.—On the diffusion of solids, by M. Colson. To a given temperature corresponds a constant coefficient of diffusion of carbon in iron. This law holds only so long as the iron is transformed into steel. Among substances that diffuse very easily in carbon, silica holds the first place. Platinum wire, heated long enough with lampblack in an earthenware crucible, becomes crystalline, and has the composition $SiPt_2$ (the silicum being from the crucible, whose silica is diffused in the lampblack). Repeating the experiment with lampblack holding 60 per cent. of precipitated silica, one obtains SiS_2Pt_3.—On the diffusion of carbon, by M. Violle. He had observed, in 1878, a diffusion of carbon in porcelain (temperature under 1500°).—Anchylostoma (duodenal anchylostoma of Dubini) in France, and the disease of miners, by M. Perroncito. The miners' anæmia of Saint Etienne has the same parasitic cause as that of the workmen in the St. Gothard, the Schemnitz miners, &c. The malady may be prevented by cleanliness and treatment of excrementitious matters with heat of 50° C. (to kill eggs, larva, and worms), or better, with concentrated solutions of chloride of sodium, sulphuric, hydrochloric or carbolic acid, or Depernis's insecticide liquid. Patients should be treated with doses of etherised extract of male fern.—On algebraic forms with several series of variables, by M. le Paize.—Integration of certain equations with partial derivatives, by means of definite integrals containing, under the sign s, the product of two arbitrary functions, by M. Boussinesq.—On the theory of motion of planets, by M. de Casparis.—On the determination of the ohm; reply to M. Brillouin, by M. Lippmann.—Measurement of potentials corresponding to determinate explosive distances, by M. Baille. The potential of an electrified plane increases nearly regularly with the explosive distance which can be traversed. The electric densities decrease at first slowly, reaching a constant value about 0.5 ctm. The pressure of electricity on the air when a spark of 0·01 m. passes is only 1-2000th of atmospheric pressure.—Note on the temperatures of the sea observed during the mission to Lapland, by M. Pouchet. In the roadstead of Vadsö the mean sea-temperature rose about 9° in 50 days from June 8 (or about 0°·2 a day). A cooling influence of the coast was observed to $1\frac{1}{2}$ miles and to a depth of 100m. at the Vadsö anchorage (a difference of about 1° for depths of 20 to 30m.). The temperature always decreased very regularly to the bottom.—On the ratio of potash to soda in natural waters, by M. Clooëez. This relates to water of the Seine, Marne, Dhnis, Vanne, &c. In general the potash counts for more than 1-5th in the sum of alkalis (potash 25, soda 100), and while the potash comes from decomposition of felspathic rocks, the soda is probably from chloride of sodium impregnating all the strata, except granitic soils. The Vanne, rising in the chalk and not meeting argillaceous deposits, has no salts of potash.—On the complex function of morphine, its transformation into picric acid, and its solubility, by M. Chastaing.—On artificial production of the forms of organic elements, by MM. Monnier and Vogt. He obtains cells, tubes, &c., by bringing together two salts in a liquid, forming by double decomposition one or two insoluble salts.—Researches on development of cryptogamic vegetation without and within hens' eggs, by M. Dareste. Such vegetation he found on most of sixty eggs submitted singly to artificial incubation in a small vessel hermetically closed with a caoutchouc stopper. He considers the spores to have entered the oviduct from the cloaca and to have been incarcerated in the egg during its passage in the oviduct. The vegetation may be fatal to the embryo.—On a parasitic tuberculosis of the dog and on the pathogeny of tuberculous follicle, by M. Laulanié. He observed in a dog's lung alterations very like those of tuberculosis, produced by eggs of a nematoid (*Strongylus vasorum*, Baillet).

Vienna

Imperial Institute of Geology, December 6, 1881.—G. Laube, on melaphyry-stones inclosed in the porphyry of Liebenau (Bohemia).—R. Hoernes, on the remains of mammalia found in the brown coal at Goeriach, near Turnan, Styria.—Th. Fuchs, on the relations of heat and light of the ocean.—L. Szajnocha, exhibition of the geological map of Taslo and Krosmo in Western Gallicia.

December 20.—C. Doelter, on the volcanic rocks of the Cape Verde Islands.—R. Hoernes, exhibition of remains of mammalia from the Styrian brown coal-deposits.—G. Stache, new data on the occurrence of olivin-rocks on the gneiss mountains of Southern Tyrol.—V. Uhlig, on the composition of the lime-rocks at Lublau (Hungary).

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THURSDAY, JANUARY 19, 1882

OUR NATIONAL DEFENCES

THE inaugural address of the President of the Institution of Civil Engineers, delivered last week, was of more than usual interest. Selecting as his subject our national defences, Sir William Armstrong was enabled by his great experience and world-wide reputation to give much greater weight to his opinions than any other engineer at the present day. The subject, too, is one to which attention can now be readily directed, as the public mind has of late been somewhat rudely awakened to the fact that our national armaments have not been making the same progress as those of certain foreign powers, and the comfortable belief that we were strong enough to withstand the attack of any possible combination of other nations has given place to a feeling of distrust in our Government establishments. There can be no doubt that the general public was not a little surprised to find that ironclads and heavy guns of a power at least equal to the best in our service were for sale ready made, so to say, in the shop-windows of some of our manufacturers, and had, on the alarm of war with Russia, to be hastily purchased by the Government to prevent their falling into the possession of a hostile power.

Sir William Armstrong first discusses the question of armour. The early ironclads, such as the *Warrior*, were plated throughout nearly their entire length with 4½-inch armour; as guns were produced of greater penetration, the thickness of armour was increased and the protected area diminished until in all the latest ships it has come to be restricted only to the battery, all vital points of the machinery being placed out of harm's way below the water-line. "Everything of importance that projectiles could destroy would be kept below water-level, and so far as artillery-fire was concerned, the ships would be secured against sinking by an under-water deck and ample division into compartments. Armour therefore seems gradually contracting to the vanishing point." Sir William plainly considers that the days of armour-plating are numbered, and he strongly argues in favour of its abandonment at least in many types of ship. As the basis of his argument he takes the comparative cost of an unarmoured and an armoured vessel capable of carrying the same weight and number of guns, and states that three of the former could be constructed for one of the latter; which then, he asks, would be the better investment? In the first place the three unarmoured ships could have higher speed, and if their guns were capable of piercing the plating of the ironclad there can be no doubt that their numerical superiority would enable them to win an easy victory if the three were matched against the one. If the ironclad was impenetrable by the guns of her adversaries they could still, by their greater speed and handiness, be enabled to come to close quarters and attack to the greatest advantage with torpedo and by ramming, unless disabled by their opponent's fire; and this Sir William considers may be provided against without difficulty by means of an underwater deck, and by placing all machinery below the water level. It would still remain for the ironclad to strike a fatal blow, by means of torpedoes, at any one of her adversaries who came to close quarters; but as the chances of this would be equal for either ship the advantage still remains with the larger number. We quite agree with Sir William Armstrong in his conclusion that light unarmoured ships of high speed, with every possible means of protection other than armour-plating, are what the country would most require in case of war, but they must be provided in sufficient numbers.

In estimating from the basis of cost the proportionate number of armoured and unarmoured ships as one to three, we cannot but think that Sir William has overlooked the cost of repairs and of the maintenance and pay of the officers and crews; if this were taken into consideration, as well as the original outlay, the proportion would have to be reduced to something like two to one. In addition to the many advantages so ably pointed out by Sir William in favour of his policy, it should be borne in mind that an unarmoured vessel could always be brought up to date by the substitution of new engines and boilers and guns of an improved type, until fairly worn out, while an ironclad cannot be prevented from becoming obsolete a few years after completion.

"It might perhaps be rash entirely to abandon armour so long as other nations continued to use it, because nothing but the experience of an actual war would remove all question as to its possible utility; but, considering the indisputable value of a numerous fleet of swift and powerfully armed ships built with a view of obtaining the maximum amount of unarmoured defence, and considering that such ships, unlike armour-clads, could never grow much out of date, it did seem expedient that the chief expenditure of this country should be upon ships of that description."

Sir William Armstrong then deals with the question of our mercantile marine being able to furnish a supply of vessels fit for conversion into cruisers, and says, "Where are there to be found amongst trading or passenger steamers, vessels possessing a speed of sixteen knots with engines and boilers below water-level, and having an under-water deck to save them from sinking when penetrated at or below the water-line? From his own experience he knew how difficult it was to adapt mercantile vessels to the purposes of war, and how unsatisfactory they were when the best had been made of them."

But if these vessels cannot be adapted for war purposes in case of need, why, it may be asked, should not specially designed and constructed cruisers be employed for mercantile purposes?

If a number were built by private firms, certain preferences and advantages could be given to their employment in commerce; for example, as giving mail contracts and the contracts for the conveyance of troops and Government materials in time of peace, only to those shipowners who kept in a serviceable condition in their carrying business a certain proportion of cruisers. A vessel of the cruiser type would of course labour under some disadvantages in competition with a ship built entirely for passenger and cargo purposes, but this would be compensated by the advantages given to her owners; and to use for mercantile purposes a number of vessels specially built for the protection of commerce in case of war must assuredly be more economical than to keep the same number laid up in port or cruising about the world for the sake of employing their crews. In connection with this system we

might also have a naval reserve, to be employed chiefly on board the mercantile cruisers and liable to service for a short period every year or two on board a commissioned ship of similar type.

Referring to harbour defence, Sir William pointed out that many of our ironclad forts had already become obsolete, and gave the place of first importance to gunboats, in combination with torpedo launches and submarine mines, all of which he suggested might be managed by a well-trained corps of volunteer engineers resident on the spot. Here again it is evident that Sir William does not think, great though our present expenditure is, that enough is done for the efficient protection of the country, and rather than advise an increased outlay he judiciously seeks, by the improvement of the system, to obtain better results for the same money.

Sir William then referred briefly to the progress made in the manufacture of guns since the introduction of rifling, but made no special allusion to the improved breech-loaders constructed by his own firm for foreign powers, and which have long been known to be much superior to anything in our own service; in fact, while guns of this type are now beginning to receive the serious consideration of our Government departments, their original designers have for some time turned their attention to something newer still and far more powerful. Sir William shortly described the latest system upon which experiments are being made at Elswick. In this system the coils surrounding the central tube consist of steel ribbon wound on spirally at a certain tension. It is apparent that no longitudinal strength is obtained in the coils by this method; and to supply this deficiency, longitudinal layers of ribbon steel are interposed at every fourth circular layer.

The advantages of the system are that steel, in the form of wire or drawn ribbon, possesses far greater tenacity than in any other form, and that the initial tension at each point in the coils of the gun can be accurately adjusted. The first gun of this type was a 6-inch breechloader, tried in the beginning of 1880, and so satisfactory were the results, that a 10-inch gun of 21 tons weight has since been constructed, and is now under trial.

The importance of working heavy guns on board ship by engine-power was pointed out as lessening the number of men exposed, and the objection that the machinery was liable to be disabled by an enemy's fire, was shown to apply equally to the mechanism required for hand-power.

In concluding Sir William adverted to a subject of grave importance. "Our navy was at present armed with guns which could not be expected to contend successfully with the best modern guns that could be brought against them." "Our service guns had simply been overtaken in that rapid progress of artillery which had been going on for the last eight or ten years."

"In the mean time no expense should be spared in judicious experiments, seeing that the expense of experiments was trifling in comparison with that of mistakes. Above all, the Government should pursue such a course as would bring into full play the abundant engineering resources of this highly mechanical country, for increasing the efficacy of our national defences."

On this last and most important point we have before laid stress in these columns. We have before pointed out that the keen commercial competition for foreign orders amongst private firms fosters a vitality and vigorous growth in the direction of any improvement or new development which is invisible, and would probably be felt inconvenient in our Government factory. It would surely then be to the advantage of this country to avail ourselves of the energy and enterprise of our private firms instead of allowing them chiefly to benefit our foreign competitors.

THE SUN

The Sun. By C. A. Young, Ph.D., LL.D. International Scientific Series. (Appleton, New York.)

SINCE the method of artificial eclipses was introduced in 1868 Prof. Young, the author of the book under notice, has from time to time done good work in utilising the capital climate of his native country and his relatively superior optical means to confirm in many essential points and to add a little shading here and there, to the bold outlines of the new science, for which we are indebted to his predecessors.

The book, which deals with the sun in the most general manner, will be read with interest, as its style, though not brilliant, is popular, and such questions as the sun's distance and the various instrumental means now at the disposal of astronomers for increasing our present knowledge are very clearly referred to, while those whose acquaintance with spectrum analysis is not very intimate, will be able to gather from the volume much interesting information conveyed in an agreeable form.

To those who have followed with some keenness the recent progress of solar physics that part of Prof. Young's book which refers to the hypothesis of the dissociation of the elementary bodies at the temperature of the sun will possess much interest, the more so as the author has been freely quoted as objecting to the hypothesis *in toto*.

On this account we do not think it inappropriate to give in Prof. Young's own words his views on this point. It is the more important to do this because very few beyond the number of those who have been more or less engaged in the inquiry have any conception of the remarkable character of the facts which have been accumulated during the last thirteen years, or of the way in which they refuse to be included in the previous hypothesis according to which we were really in presence of terrestrial elements in the sun and stars, the old hypothesis being based upon the asserted identity of the solar and stellar spectra with those seen in various terrestrial light sources.

The extracts run as follows:—

"When we recollect that the non-apparent elements constitute a great portion of the earth's crust, the question at once forces itself: What is the meaning of their seeming absence? Do they really not exist on the sun, or do they simply fail to show themselves; and, if so, why? The answer to the question is not easy, and astronomers are not agreed upon it. Mr. Lockyer has, however, proposed a theory which, if established, would remove most if not all of the spectroscopic difficulties. He thinks that our elements are not really elementary, but built of molecules themselves composite and capable of dissociation by the action of heat. Thus, a mass of chlorine, for instance may at a certain temperature break up into constituents

and so it may easily be the case that at solar temperatures certain of our terrestrial elements cannot exist, or, if they exist at all, can do so only in certain very restricted regions of the solar atmosphere.

"One strong argument in favour of this view is found in the fact, now we think beyond dispute, that the same substance may, under different circumstances, give widely different spectra. . . ."

"There seem to be at least three possible explanations of these facts. One is, to suppose that the luminous substance, without any change in its own constitution, vibrates differently and emits different rays under varying circumstances, just as a metal plate emits various notes according to the manner in which it is held and struck. The second assumes that the substance, without losing its chemical identity, undergoes changes of molecular structure (assumes allotropic forms) under the varying circumstances which produce the change in its spectrum. According to either of these views, although we can safely infer from the presence of the known lines of an element in the solar spectrum, its presence in the solar atmosphere, we cannot legitimately draw any negative conclusion; the substance may be present, but in such a state under the solar conditions as to give a spectrum different from any with which we are acquainted.

"The other and simplest explanation is to suppose, with Mr. Lockyer, that the changes in the spectrum of a body are indications of its decomposition, the spectrum of the original substance being replaced by the superposed spectra of its constituents."

"Another point which favours Mr. Lockyer's view is this: Certain substances have numerous lines apparently common. Thus, if one runs over Ångström's map of the solar spectrum, he will find about twenty-five lines marked as belonging both to iron and calcium. The same thing is true of iron and titanium to a still greater extent, and to a considerable degree of several other pairs of substances. This fact might be explained in several ways. The common lines may be due, first, to impurities in the materials worked with; or, second, to some common constituent in the substances (which is Mr. Lockyer's view); or, third, to some similarity of molecular mass or structure which determines an identical vibration-period for the two substances; or, finally, it may be that the supposed coincidence of the lines is only apparent and approximate—not real and exact—in which case a spectroscope of sufficient dispersive power would show the want of coincidence."

"Now, Mr. Lockyer, by a series of most laborious researches, has proved that many of the coincidences shown on the map are merely due to impurities. . . . . But when all is done, we find that certain of the common lines persist, becoming more and more conspicuous with every added precaution taken to insure purity of materials.

"Moreover, when one of the substances, say the calcium, is subjected to continually increasing temperatures, its spectrum is continually modified, and these basic lines, as Mr. Lockyer calls them, are the ones which become increasingly conspicuous, while others disappear. This is just what ought to happen if they are due to some element common to both iron and calcium—an element liberated in increasing abundance with every rise of temperature" (pp. 89–92).

"A given element often has several entirely different spectra. Changes, such as have been mentioned, go on up to a certain point, and then, suddenly, an entirely new spectrum appears, not having apparently the slightest connection with the one which preceded it any more than if it came from an entirely different element or mixture of elements; as, in fact, according to Mr. Lockyer's view, is probably the case.

"Now, in the solar spectrum, the dark lines characteristic of an element are all coincident with the bright lines of its gaseous spectrum; but it is not often the case that the relative width and intensity of the solar lines match those of the bright lines in the spectrum obtained by artificial means" (pp. 96-97).

"In the motion-distortions of lines Lockyer finds strong confirmation of his ideas. It not unfrequently happens that in the neighbourhood of a spot certain of the lines which we recognise as belonging to the spectrum of iron give evidence of violent motion, while close to them other lines, equally characteristic of the laboratory spectrum of iron, show no disturbance at all. If we admit that what we call the spectrum of iron is really formed in our experiments by the superposition of two or more spectra belonging to its constituents, and that on the sun these constituents are for the most part restricted to different regions of widely varying pressure, temperature, and elevation, it becomes easy to see how one set of the lines may be affected without the other" (p. 100-101).

It will be gathered then from these extracts that in Prof. Young's opinion, whatever that opinion may be worth, and we for our part attach great value to it, the new hypothesis does get rid of a good many of the difficulties of the old one, and surely this is the best justification any worker in science can have for suggesting an hypothesis. It is to be noted also that several of the various converging lines of evidence, especially those depending on the changes in spectra, are referred to. It is imagined by some that the new hypothesis breaks down if a line apparently coincident in the spectra of two substances at small dispersion should turn out to be non-coincident when a higher power is employed, while the fact is that the assumption that there should be such coincident lines, if *we can reach a particular temperature*, is based upon one manner of behaviour of compound bodies to the exclusion of another, and on such points as these we are as yet in profound darkness.

The chapter on the sun's light and heat, and the appendix on Prof. Langley's recent work will well repay perusal.

THUDICUM'S ANNALS OF CHEMICAL MEDICINE

Annals of Chemical Medicine. Vols. I. and II. By J. L. W. Thudicum, M.D. (London: Longmans, Green and Co., 1879.)

THOSE who open this work expecting to find it adequately fulfilling the promise of its title will be disappointed. Had they read the initial preface they would have been prepared for this, for it indicates very clearly the intention of the promised series, of which the first two volumes are now published.

Dr. Thudicum is well known as the author of numerous researches in Animal Chemistry, which are chiefly remarkable for the large number of new bodies described in them, and the somewhat fantastic names he has assigned to these bodies. Somehow or other the results of these researches have not met with that general acceptance which their author desires; indeed they have in many cases been either to a great extent passed over or else their value called into question by those who have repeated his experiments or worked at the same parts of the subject. This is clearly recognised by the author in the preface to the first volume, and has accordingly led him, on the assumption that one cause, among

others, of this neglect is the scattered nature of his publications, to commence republishing his researches in a "consolidated" form with the addition of new work. Whether this will in future prevent the neglect under which the author feels he has laboured remains to be seen; that he himself so far is satisfied with the results following the appearance of the first volume is evident from the preface to the second.

The only original matter in these volumes other than that of the author consists of one short note by the author's son, so that there has apparently been no response to the invitation to contribute to these "Annals" which was issued with the first volume.

The larger part of each volume is made up of a series of summaries of work which has been done in various branches of Physiological Chemistry; these contain a good deal of information of a fragmentary kind, but can scarcely be regarded as adequately presenting to the reader the present state of opinion on the subjects of which they treat. This is especially the case in the summaries contained in the second volume. "Visual-purple" receives very rough treatment in Article III.; the account of researches on the source of urea in the body is anything but complete, and the same may be said of Article XVIII., on fibrin and its precursors. It is, however, only fair to say that many of the summaries are much less open to objection.

The preface to the first volume contains a charge of malevolent and ignorant opposition to the author's work, which reaches its full development in his concluding remarks to Article XIX., on the existence of Protagon; in these he accuses those whose work is opposed to his own, not only of incompetence, but of what is best known as "cooking"; he speaks of them as obtaining "extracts of uniform composition" "by the aid of processes nearly akin to trimming." The reference is obvious. Similarly in the second volume, Article XVI., "Modern Text-Books as Impediments to the Progress of Animal Chemistry," consists of a review of Prof. Gamgee's "Text-Book of Physiological Chemistry," in which this work is characterised as "humiliating to scientific literature." Comment on this article may safely be left to the individual judgment of those who take the trouble to read it. It may, however, not be out of place to suggest here that a continuance of this tone in future volumes towards those whose work is at variance with the author's, will undoubtedly do much to alienate from him any sympathy with the "Annals" which physiologists might otherwise have been inclined to extend to them.

OUR BOOK SHELF

Kufra. Reise von Tripolis nach der Oase Kufra. By Gerhard Rohlfs. With Eleven Drawings and Three Maps. (Leipzig: F. A. Brockhaus, 1881.)

THIS new volume of travels by Dr. Gerhard Rohlfs is a valuable contribution to a knowledge of the southern parts of the Vilayet of Tripolis and of the Lybian Desert. In December 1878, Herr Rohlfs, accompanied by Dr. Stecker, started from Tripoli, and soon reached the interesting oasis of Djofra, or Sokna, already known from the travels of many Europeans. Thence he proceeded east-south-east to Aujila, crossing the formerly quite unknown tracts of the sandy and stony deserts situated at the north-eastern foot of the Black Mountains. He reached the green and pretty oasis of Sella, which is one of the richest of the Eastern Sahara, and has no less than 100,000 palm-trees, and large flocks of camels. Going further east to Abu-Naim, Herr Rohlfs did not follow the usual route, but, avoiding encounters with robbers, he made a great bend towards the south, having thus the opportunity of visiting the hilly tracts of the spurs of the Harauj-assod Mountains, watered during the rainy season by numerous Wadi. On March 24, 1879, he reached the small but wealthy Abu-Naim, whose numerous fossils, as well as foraminifera scattered in its sands, will probably attract the attention of future explorers, Herr Rohlfs' collection having been plundered by robbers. A few days later he was in Aujila, which he already had visited in 1869. But his further advance being checked by the fanaticism of the inhabitants, he was compelled to send Dr. Stecker, and one month later to go himself to Bengasi, on the Mediterranean coast, to obtain there some protection for his journey to Kufra. It was only in July that he was enabled to return to Aujila, and to start for Kufra, 350 kilometres distant due south of Aujila. The oasis, situated between 26° and 24° N. lat., and 21° to 24° E. long., is elevated 250 to 400 metres above the sea-level, and is far larger than it was expected, as it covers 17,818 square kilometres. It must have been once a great salt lake, and even now it is covered with brackish marshes, and has a small lake; but sweet water is found everywhere in this oasis at a small depth, and throughout its length and breadth it is covered with vegetation. From Kufra Herr Rohlfs returned to Bengasi, after his caravan had been plundered by the inhabitants.

The work contains interesting observations on the sinking of the North African coast, and gives a good description of the physico-geographical conditions of the Eastern Sahara. There are illustrations and a map of the region visited, and more detailed maps of Djofra and Kufra. In the second part of the book we find a list of new routes in Tripolitania; a list of temperatures of wells, observed by Dr. Stecker; a paper on altitudes and on meteorological observations by Dr. Hann; papers on the Amphibia and Arthropoda collected by the Expedition, by Dr. Karsch; and an elaborate paper, by Dr. Ascherson, on the plants collected during the last seventy years in Central Africa—the catalogue of Dr. Ascherson mentions 437 plants from Tripolitania, 200 from Fezzan, 48 from the Aujila oases, and 493 from Cyrenaica.

Tables of Qualitative Analysis. By H. G. Madan. (Clarendon Press, Oxford, 1881.)

IT is surely high time that students of chemistry were taught qualitative analysis by some other method than by following a very complicated table of analysis. That very important stage of chemical learning, qualitative analysis, would be much more thoroughly mastered if the student were well exercised in the reactions of the elementary substances, and then led to construct methods of separation himself. He would by this means become independent of tables and books in the laboratory. Students who are accustomed to work with, or follow, a table, often lose much time in finding where they are working on the table, and get on the "left side" of the group when they should be on the other. The tables before us would doubtless be useful to an advanced student, but appear certainly very complicated to be put into the hands of a beginner. No notice is taken of the so-called rare elements, but a good table of solubilities is supplied—a part of an analysis book that students might benefit by consulting a little oftener than is usually the case. Although produced in the usual good style of the Clarendon Press, a somewhat smaller form would perhaps be more convenient for use on the laboratory benches.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Tidal Evolution and Geology

IT appears to me that the difference of opinion between Mr. George Darwin and his interpreter, Dr. Ball, is very small. Dr. Ball is careful to confine his large tides to the Eozoic rocks, and has not asserted their efficacy in Carboniferous times.

The Laurentian rocks form nearly 19 per cent. of the total known thickness of strata of all ages, and occur at the bottom of all; but we must ascend through nearly 66 per cent. of the total thickness before we reach the lowest bed of the Carboniferous period; and it is plain that Mr. Darwin's large tides may have existed (as Dr. Ball suggests) in the Eozoic period, and have become much smaller before the Carboniferous period began.

The real importance, in my opinion, of a large tide considered as a geological agent, depends upon its rise and fall, and not upon its ebb and flow. The waves of the sea, agitated by the wind, make the ocean surface a vast planing-machine, acting upon the coast-lines; and a great range of tide applies this planing-engine either twice or four times a day to every part of the coast laid bare by the rise and fall of tide. The effects must have been very serious when the day was six or eight hours long.

The claim for priority made on behalf of Kant, by the metaphysicians, must be set aside, as Kant's statement was not based on sound dynamical principles. SAMUEL HAUGHTON

Trinity College, Dublin, January 17

I WAS much interested in reading Prof. Ball's lecture in NATURE, vol. xxv. p. 79, but failed to understand the following passage on p. 81:—"*The reaction of the earth tends to increase that distance*, and to force the moon to revolve in an orbit which is continually getting larger and larger." In what sense does the reaction of the earth tend to "drive away" the moon? Will the Royal Astronomer of Ireland, or some other friend of science, be so kind as to add a few words of explanation? J. R. B.

The Remarkable White Spot on Jupiter

EARLY in the present month this singular object became obscured, so that on January 1 I could scarcely distinguish it at all, and on the 3rd, 5th, and 6th it was noted as extremely faint. The origin of the spot's disappearance was obvious. A dark mass on the north border of the great south belt (and therefore in the same latitude as the white spot) appeared on December 14; it followed the white spot 1h. 4m., according to observations by Mr. A. S. Williams at Brighton. The dark spot moved with more rapidity than the latter, and soon overtook it, so that as the former swept over it, its disappearance was complete. On January 6 the white spot was seen struggling through the south-east limits of the dark patch. On January 7 it had further freed itself, and I saw it much plainer, though it still continued somewhat faint. On January 9 it was bright, and evidently on the point of regaining its normal brilliancy. The dark patch referred to is obviously of the same character as the train of black spots visible on one of the northern belts last winter; they move with even greater velocity than the white spot, and are somewhat evanescent as regards duration. They appear to be excrescences from the surface of Jupiter, and as they near the outer envelopes, are dispersed into longitudinal bands; in fact, it is these dark spots which sustain the decided tone of the belts, for the latter show a disposition to become fainter, until reinforced by the commingling of these dark eruptions.

As to the brilliant white spot, it is an object of notable permanency; and though it failed to come generally under notice until October, 1880, it had probably been a conspicuous marking on Jupiter during the few preceding years. Certainly in 1879 it was very bright, and several times observed by Dr. F. Terby at Louvain, and Mr. J. Gledhill of Mr. Crossley's observatory, Halifax. I computed back the dates of its conjunctions with the red spot, and found the following nights in 1879–80 when it might have been well observed:—

1879, September 1	1879, November 29
,, October 16	1880, January 13

The date of November 29 is amply confirmed both by Dr. Terby and Mr. Gledhill as follows:—

1879, November 27, 5h. 40m., a brilliant white spot ("Tache brilliante et blanche") slightly east of the *f.* end of the red spot.—Terby.

1879, November 29, 6h. 30m., a bright gap into north border of the great south belt. It is situated about a quarter the distance from the middle to the *p.* end of red spot.—Gledhill.

In two days the white spot traverses an extent of longitude equivalent to half the length of the red spot, so that the above observations are quite consistent, and there can be no doubt that they relate to the curious object at present visible. Mr. Gledhill's drawing of November 29 shows the spot to be some twelve hours past conjunction with the red, so that the phenomenon probably occurred on the *morning* of November 29, which is not far from the computed time. The ensuing conjunction on January 13, 1880, is confirmed by Dr. Terby. On January 11, 6h. 16s., he saw a brilliant white spot occupying the same longitude as the *f* end of the red, which is exactly the computed place, and there can be little doubt that these white spots are identical with each other and with the white spot of to-day.

Mr. Gledhill's drawings supply other interesting facts. Thus at 6h. 45m. both on November 13 and December 8, 1879, there was a brilliant white spot or gap (in the north side of the great southern belt) about ½h. past the central meridian. These observations again conform to the positions of the present spot, which in the interval between the two dates mentioned had performed sixty-one rotations. It is curious that at periods of twenty-five days (equal November 13 – December 8 as above) the transits of the white spot recur at very nearly similar times. Mr. Gledhill's observed conjunction of November 29, 1879, compared with my own similar observations on December 24 last year proves that the white spot had completed seventeen revolutions of Jupiter in the 756 days!

If possible it is important to trace still further back the apparitions of the white spot. The special brilliancy of this object and its unique position indenting the north side of the southern belt, could hardly escape notice unless indeed the spot was temporarily obscured, as it sometimes is, when the dark patches sweep over it. This brilliant spot should have been nearly in the same longitude as the red spot on the following dates in the last half of 1878:—

July 29	October 26
September 11	December 10

Can observers furnish any additional links in the previous history of this wonderful object? W. F. DENNING

Ashley down Bristol, January 10

Fossil Insects of the Dakota Group

THERE are till now, as far as I know, no fossil insects out of the Dakota group published. Among a large number of fossils belonging to this group, and collected by Mr. Chas. H. Sternberg, some of the leaves show insect galls and mines, the latter mostly of a decided Tineid and Tortricid character. Perhaps a list of those plants may be of interest. The determination of the plants is by Mr. L. Lesquereux[1]:—*Aspidiophyllum trilobatum*, 6 specimens; *Sassafras cretaceum*, 1; *Araliopsis grossedentata*, 4; *A. cretaceum*, 2; *A. mirabile*, 4; *A. acutiloba*, 1; *A. Haskenanum*, 1; *Ficus primordialis*, 1. Mr. Sternberg informs me that this is only a partial list of his fossil plants, which were all collected in Central Kansas. Among the plants figured in the Cretaceous flora by Mr. L. Lesquereux (Hayden's "Survey," vol. vi.), I find on the following plants insect mines or galls:—*Menispermites obtusiloba*, *Greviopsis Heydenii*, *Protophyllum Sternbergii*, *Platanus recurvata* and *Heerii*, *Liquidambar integrifolium*. All from Kansas or Nebraska. Mr. F. B. Meek ("Cretaceous Invertebrata" in Hayden's Rep., vol. ix. p. xliv.) says: "The evidence respecting the exact part of the European Cretaceous series to which the Dakota group belongs

[1] I am informnd by Mr. Lesquereux that a large number of Magnolia leaves from the Tertiary of Alaska show serpentine trails not larger than a thread running all over the leaves, apparently under the epithelium.

is not entirely satisfactory. . . . The modern affinities of the numerous leaves of the higher types of dicotyledonous trees found in it, present a strong objection to the adoption of the conclusion that it may belong to a lower horizon than the Upper Greensand of British geologists; while its position directly below beds almost beyond doubt representing the Lower or Gray Chalk, precludes its reference to any higher stratigraphical position. Consequently, we have long regarded it as most probably representing in part, if not the whole, the Upper Greensand. . . ." As the fossils above mentioned belong to the Museum of Comparative Zoology, I hope to be able to give more detailed information upon these galls and mines.

Cambridge, Mass., January 3 H. A. HAGEN

On Combining Colour-Disks

THE paper of Lord Rayleigh in NATURE (vol. xxv. p. 64) describing experiments on colour, gives near the close a method of observing the image of colour-disks seen through an inverting prism in rapid rotation, while the disks were at rest. This recalls to mind a method somewhat similar that I have tried, that will sometimes be found convenient as well as simple: Here the image of the stationary disks is formed in a plane mirror slightly inclined to the axis around which it rotates; by properly proportioning the angle of inclination, the distances from the mirror to the eye and disks, and the sizes of the mirror and disk, it is obvious that a good combination of the colours may be effected, while the adjustment of colours is easily effected without stopping the rotation. If, as with my instrument, the clockwork is not heavy enough to give easily the desired speed when the disks are mounted on it, a much higher speed can be obtained with the light mirror: indeed, the mirror might be attached to the end of a wire resting on two supports, and rotated by unwinding a string, and thus colour combinations could be simply effected, and with cheap apparatus. Of course here, as with the inverting prism, the line of vision is inconveniently limited; but with both methods the uncertainty arising from unequal illumination of different parts of the disk may be detected by giving to the disk a slow rotation on its own plane.

CHARLES K. WEAD

University of Michigan, Ann Arbor, U.S.A., December 31, 1881

Sound-Producing Ants

WITH reference to the question whether ants produce sounds which are of such a pitch as to be inaudible to the human ear, I should like to make a suggestion which occurs to me, but which I have no means of carrying out practically. It is a well-known acoustical fact that two notes of high pitch sounding together produce a third whose vibrational number is the difference of the vibrational numbers of the two primary notes. If now we suppose a vibration at the rate of (say) 60,000 per second, another at the rate of 38,000 per second would give a difference note of 22,000 per second, which would be well within the range of audibility. If then we send up a note beyond the extreme limit of audibility, we shall be able to detect the presence of vibrations which exceed that of the note sent up by the highest number of vibrations of audible sound. It would be interesting to know if this has been attempted, and if the microphone can be applied to assist in the investigations.

Hirwain, Aberdare, January 10 D. M. LEWIS

Nepotism?

PLEASE, Mr. Editor, is a pet baboon (NATURE, vol. xxv. p. 217) more interesting than either a pet sparrow or a pet canary bird? Don't give rise to the suspicion that there is any nepotism in the affair! JOHN H. VAN LENNEP

Zeist, January 10

INDIAN FOSSILS.—Mr. J. W. Oliver informs us that at the Birmingham and Midland Institute there is a small collection of Siwalik fossils which, he understands, were sent some years ago from the British Museum. Prof. Prestwich writes that there is a very large and fine collection in the Oxford University Museum, presented by Dr. Falconer and Sir Proby Cantling. Prof. Prestwich will be happy to give Mr. Lydekker every facility for the examination of the specimens.

COMPRESSED AIR UPON TRAMWAYS

FEW persons unconnected with the practical working of the companies are aware of the great amount of time, labour, and money which have been devoted to the substitution of mechanical for horse-power upon tramways both in this country and abroad. The principal incentive to this exertion has been the large margin of saving which has presented itself in the light of a premium to inventors and capitalists. Motives of humanity towards the horses have also had considerable influence, especially with Parliament, and have contributed in no small degree to the legislative sanctions which have been obtained not only by particular companies, but by the tramway interest in general. In no case however that the writer is aware of, have the tramway companies themselves made any material contributions towards the solution of the problems involved. When the story of the subject comes to be written it will be found full of arguments in favour of the principle that the monopoly granted to inventors by the patent laws is nothing more than a clumsy method of spurring them to exertion, and of providing a remuneration for success which never covers the aggregate losses of failure by which the whole community have been indirectly benefited.

The fact of the horse-tramway companies having refused to assist inventors with money is fully accounted for and rendered excusable not only because they have no funds placed at their disposal by their articles of association for such a purpose, but also because the investment would have been far too speculative to have been sanctioned by the shareholders. Where the companies appear to the writer to have been at fault is that while the margin of saving as between a successful invention and horse-traction is admitted to be enormous, because the invention could hardly be said to be successful unless the margin was a large one, they have never admitted either individually or collectively that some substantial share of the saving should be the reward of the successful inventor. The writer has no hesitation in saying that if the leading companies had put the issue clearly before the inventive capacity of the engineering profession in the shape of an offer of say 30 per cent. of the actual saving in the shape of royalty to the inventor that the problem would have been solved at least six years ago. The far-stretching results of such a revolution, even within the comparatively confined area of the tramway interest, would be incalculable. Not to speak of the emancipation of the horses, the employment of capital in channels so consistent with the spirit of the age and the genius of the country as the manufacture of machinery would have economic results affecting the welfare of whole classes of the community, and the impetus given to the intramural locomotion of our large cities would go far to overcome the pressure of difficulties affecting the housing of the poor, which contribute more to the unrest of the people and the propagation of socialistic ideas than the wealthier classes are aware of. The policy of the tramway companies, however, appears to have assumed the character of a fixed determination to give nothing in return for the advantages which would accrue to them from the adoption of a successful mechanical substitute for horses. So long as they maintain this attitude the problem is likely to remain unsolved. Licensees of inventors have followed their example, and at least one case is known to the writer in which a gross breach of agreement has debarred the adoption of an invention which is notoriously efficient. Time no doubt will expose the guilty parties, and their names, instead of being honourably associated with the advance and improvement of mechanical science, will be handed down to posterity with the contempt which they deserve.

A description and illustration have already been given in these pages of a system of tramway traction by means of electricity, and this is no doubt safe in the hands of

the distinguished specialists who have taken it up. In the paper which the writer read recently before the Institute of Mechanical Engineers at Manchester, and which has already been reproduced in the engineering journals (see *Engineering*, vol. xxxii., No. 829), a sufficient explanation of his views was given upon the merits of the use of steam locomotives upon tramways compared with compressed air. The objections to steam were based principally upon its failure to comply with the necessary conditions of street traction in the matter of freedom from smell and dirt, and also on account of the excessive cost incurred by the maintenance of small high-pressure boilers and machinery. No such objections can be urged against the use of compressed air, as compared with electricity, because in both cases there is nothing to give trouble or annoyance from the residual products. In the one case the air escapes in its original purity to the atmosphere from whence it was derived, and in the other a still more subtle transference of force occurs, in which the conversion of one form of energy into another is all that takes place in order to effect the object aimed at. The overhead wire, in the Siemens system, which is the stage at which the invention at present stands, is a disadvantage as compared with a self-moving car in which no such obstruction is necessary to its working. Overlooking this objection to the rival system which may possibly be overcome by the use of accumulation of electric force in the vehicle itself, the point upon which the success of both must ultimately turn is that of their comparative economy. At present there are no figures to hand that can satisfactorily decide the question. In both cases a stationary engine is a necessary adjunct in order to supply a source of energy, and the future of both hinges (1) upon the comparative cost of the plant, and (2) upon the percentage of useful work which can be obtained from the use of compressed air and electricity respectively. These questions can only be answered by the trial of both upon a commercial scale, but it may safely be said in the meantime that there is nothing to lead to the conclusion that compressed air will appear to a disadvantage either as regards the necessary outlay in machinery or in the percentage of useful work to be obtained from it as compared with electricity.

The conditions which effect the useful effort exerted by a steam-engine through the intervening medium of a permanent elastic fluid such as air, employed as the ultimate vehicle of the original force upon a piece of mechanism, are first the loss from friction of the compressing apparatus ; second, the loss represented by the difference between the temperature of the air as freshly compressed without radiation, and the temperature of the air as used in the second engine. These may be spoken of as the primary losses of energy. The secondary losses are : first, the friction of the secondary engine ; and secondly, the losses arising from its inability to utilise the whole of the force contained in the air as compressed and cooled. Now the theoretical losses arising from these various causes are all easily determined, with the exception of that arising from the defects of the secondary engine, and this, which amounts to more than all the rest put together, not only varies in each separate case, but may be fairly looked upon as being capable of indefinite reduction by discoveries and improvements in the apparatus itself.

With regard to the fixed losses : the one which occurs from the loss of heat due to compression and subsequent cooling is one that can be restored under circumstances of peculiar economy, as there is perhaps no condition in the whole range of physics which lends itself so readily to the economical conversion of heat into work as raising the temperature of an elastic fluid under compression and making use of it at a corresponding pressure. It must be remembered, however, that what we are dealing with in practice is not so much the saving of every heat unit of the original supply for the purpose of producing a theoretical result and a beautiful experiment, as bringing the gross expense of the fuel used in the original steam-boiler to a point that leaves a sufficient margin as compared with horse traction, and in such a manner as not to interfere with the convenience of passengers. The writer has already in actual practice brought this gross sum per mile for fuel to $\frac{1}{2}d.$ when coal is used costing 10*s.* a ton, a common enough price in districts where tramways are in use. Now in attempting to reduce the cost of fuel to a smaller fraction of a penny than $\frac{1}{2}d.$ per mile run, it occurred to him that the effort should be made first in the direction in which the greatest loss occurred. This is certainly to be found in the defects of the secondary engine if an ordinary reciprocating steam-engine is employed, and an explanation of the writer's work in adapting it to the use of compressed air will be found in the paper already referred to. The result of his experience has gone to show that it is hopeless to obtain an economical result from reciprocating engines as at present arranged for the use of steam, without some special appliances such as he has adopted for making use of the ever-varying rates of expansion necessary in the case of a self-moving car. By reason of the additional apparatus required for re-heating the air resulting in grave inconvenience, and effecting an economy of perhaps not more than one-fifteenth of a penny per mile in fuel, he has not as yet included a heating appliance in the arrangements, and strong arguments would require to be brought to bear upon him before he determined upon doing so. The importance of introducing a heating apparatus would turn more upon what might by gained by adding to the capacity of a self-moving air-car with the view of making it capable of overtaking a particular journey for which the cold air was insufficient, than upon a mere question of economy, but even in this case he believes it would be more convenient and economical to add to the quantity and pressure of the air in the receivers than to make use of a separate heating appliance to obtain the same result.

Compressed air as a locomotive power is represented by three different systems, known respectively by the names of their inventors. All of them are more or less protected by patents, and taking the dates of the patent specifications as the standard of priority, the writer's stands first upon the list. The other two are known as Mékarski's and Beaumont's. The writer is the only one of the three who has made public in this country, otherwise than by patent specifications, the scientific work which he has overtaken, and the exact principles upon which his engines have been constructed. Before Col. Beaumont took out a patent at all he had driven in the writer's car and examined it, but as he has departed from his original specification the writer has had no means of comparing the efficiency of the engines, as recently constructed, with his own. On the occasion of his reading the paper at Manchester already referred to, a letter from Col. Beaumont was read by M. Bergeron, in which it was stated that the engine now running at Stratford used 10 cubic feet of air per mile at 1000 lbs. pressure per square inch, or 666 cubic feet at atmospheric pressure. This efficiency is more than 50 per cent. less than the writer's car, without allowing for the loss of power arising from the use of a heating apparatus, and the higher initial pressure of 66 as compared with 26 atmospheres to begin with. If this statement is correct the writer's views with regard to a moderate pressure and avoiding the use of a heating apparatus, except when absolutely necessary, are fully confirmed.

A heating apparatus, and reducing the initial pressure of the air by means of what is known as a reducing valve, are essential elements of the Mékarski system, but the engine would require to be considerably modified before it could comply with the requirements of the Board of Trade in this country.

The experiments which are now being made by the

Beaumont Compressed Air Engine Company at Stratford with a separate engine, hauling an ordinary passenger car behind it are likely to bring the question prominently before the notice of tramway companies, and the hopeful remarks made before the last meeting of the British Association by Sir Frederick Bramwell, with regard to the use of compressed air, must have contributed towards the same result. The experience of the writer, who has been longer at work on the subject than either of the representatives of the systems referred to is, however, so much opposed to their proposals, that he does not feel himself to be an altogether unbiased critic of their proceedings. It is sincerely to be hoped, for the sake of suffering horseflesh, and in order to promote the expansion of intramural locomotion throughout the country, that a fair trial may soon be given to the rival systems, including electricity. This, however, is but a remote contingency if tramway companies continue to adhere to the principle, or rather no principle, that they have to get everything, and the men who add to their dividends nothing, for their pains. The writer's car, which can be seen at work by any one interested, is entirely self-contained, and offers absolutely no obstructions to the convenience of passengers, and it carries forty of them a distance of more then seven miles with a low and safe pressure of air in the receivers, and without replenishing the supply. The distance it would travel with the pressure used in Col. Beaumont's engine is over twenty miles with one charge of air. The weight complete, including the fittings for passengers, is less than that of any compressed air tramway engine which the writer knows of, hauling a tramway car behind it.

W. D. SCOTT MONCRIEFF

SEA FROTH

I HAVE just read with interest Dr. Gladstone's article in NATURE (vol. xxv. p. 33) on "Sea Froth." I venture to inclose, as an illustration of his nephew's observations, portion of a description of such froth as witnessed by myself during a Mauritius hurricane, extracted from a book I am now publishing. It will be noticed how that close observer of nature, Bernardin de St. Pierre, depicted the same a century since in the same locality.

"This remnant of wreck had been washed bodily out of the deep water to within the outer barrier of reef on to a ledge, and was wholly out of the water, which position thus saved it from entire destruction, as only a portion of the enormous waves, which broke along the entire reef for miles, actually struck the remaining moiety, for the vessel had broken in two, and the stern-half had entirely been destroyed by the prodigious force of the breakers, the sound of which oceanic passion rose high above the din of the nearer dashing waves. Without the reef, sea and sky, ocean and air, were commingled, indistinguishable, 'a complete annihilation of the limit between sea and air.' Within the reef, the shallower sea presented a most wonderful sight, such as few can describe; it was what Bernardin de St. Pierre, nearly a century since, termed [1] '*Une vaste nappe d'écumes blanches creusés de vagues noires et profondes*'; and what Victor Hugo, in his 'Travailleurs de la Mer,' has aptly described in European waters as '*d'eau de savon*,' [2] a sea of soapsuds and lather, the lather flying in snowy flakes like thistle-down.

[1] The description given by Bernardin de St. Pierre of the view from the sea-shore on the north-east side of Mauritius is so true, and so evidently sketched from nature, that it will ever bear repetition. "Chaque lame qui venait se briser sur la côte s'avançait en mugissant jusqu'au fond des anses, et y jetait des galets à plus de cinquante pieds dans les terres; puis venant à se retirer, elle découvrait une grande partie du lit du rivage, dont elle roulait des cailloux avec un bruit rauque et affreux. La mer, soulevée par le vent grossissait à chaque instant, et tout le canal compris entre cette ile et l'ile Ambre n'était qu'une vaste nappe d'écumes blanches creusées de vagues noires et profondes. Ces écumes s'amassaient dans le fond des anses, à plus de six pieds de hauteur, et le vent qui en balayait la surface les portait par-dessus l'escarpement du rivage à plus d'une demi-lieue dans les terres. A leurs flocons blancs et innombrables qui étaient chassés horizontalement jusqu'au pied des montagnes, on eût dit d'une neige qui sortait de la mer."—"Paul et Virginie" (Ed. 1879, Hachette).

[2] "La mer à perte de vue était blanche; dix lieues d'eau de savon emplissaient l'horizon."

"[Both the above authors, incomparable in their respective lines, have, it will be observed, used somewhat similar imagery, which is sufficient proof of its fidelity to realistic facts. I have only seen one painter's drawing which has at all even faintly attempted to copy these soapsuds of the sea, '*L'énorme écume échevelait toutes les roches*,' and that only on a small scale, viz. Mr. Frank Miles' study of a curling wave before it breaks on 'An Ocean Coast: Llangravieg, Cardiganshire' (No. 342), in Gallery No. IV. of last year's Academy.[1] The rendering of the blotches of foam,[2] which curdle on the hollow curved side and translucent crest of the breaking wave, are praiseworthy in their transcription, although their perspective has been blamed by some critics. '*L'écume ressemblait à la salive d'un léviathan*' Mr. Miles ought to have given to his drawing the lines from Keats, quoted by Ruskin as the *perfect* expression of the peculiar action with which foam rolls down a long wave:

"'Down whose green back the short-lived foam, all hoar,
Bursts gradual with a wayward indolence.'

I cannot forbear giving Ruskin's imagery, as bearing out the above similes:—"The water from its prolonged agitation is beaten not into mere creaming foam, but into masses of accumulated yeast, which hang in ropes and wreaths from wave to wave, and where one curls over to break, form a festoon like a drapery from its edge; these are taken up by the wind, not in dissipating dust, but boldly in writhing, hanging, coiling masses, which make the air white and thick as with snow, only the flakes are a foot or two long each: the surges themselves are full of foam in their very bodies, underneath, making them white all through, as the water is under a great cataract; and their masses, being thus half water and half air, are torn to pieces by the wind whenever they rise, and carried away in roaring smoke, which chokes and strangles like actual water.' See 'Of Truth of Water' ('Modern Painters,' vol. i. part 2, sec. v. Chap. III. p. 375."

S. P. OLIVER

[1] An exhibition of paintings and drawings of "The Sea" is announced this winter, as to be held in the Gallery of the Fine Art Society, 148, New Bond Street.

[2] "Les flocons d'écume, volant de toutes partes, ressemblaient à de la laine."

ON THE HEIGHTS OF THE RIVERS NILE AND THAMES

COLONEL DONNELLY has put into my hands information from which the following results have been obtained:—

The information regarding the Nile has been derived from General Stone (Pacha), who has forwarded to the Science and Art Department a graphical representation exhibiting the height of the River Nile above the zero of the Cairo Nilometer for every five days, or six for each month from the beginning of 1849 to the end of 1878.

The information regarding the Thames has been derived from Sir F. W. E. Nicolson, who has forwarded a daily record of the levels on the lower sill of Teddington Lock when the tidal water has all drained off. This record extends from the beginning of 1860 to the end of 1880.

At present it is impossible to deduce from these records the volume of water which passes in unit of time across a section of these rivers: nevertheless the results give us a good deal of information, for we may be sure that an increase in depth denotes an increase in the volume of the water carried by the river and a decrease in depth a diminution of the same.

The results deduced I have embodied in a series of tables. In Table I. the yearly sum represents the whole area above the zero of the Cairo Nilometer of the graphical curve for the year in small squares whose base represents five days, and height one decimetre.

In Table II. we have the dates of maximum height of the Nile, reckoned from the beginning of September as a zero date and the sums of the numbers for two years taken.

In Table III. the numbers record sums for two years of monthly means of the water level at Teddington. reckoned in feet and decimals of a foot; that is to say each number must be divided by 24 in order to get the *mean* of the two years.

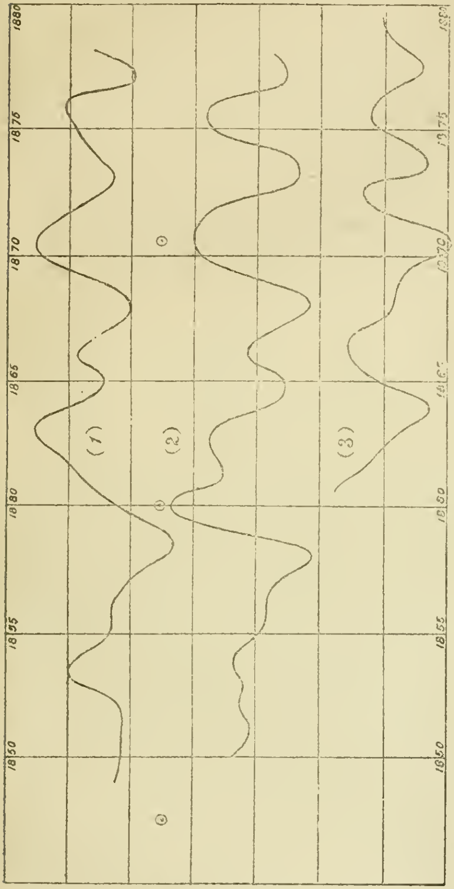


TABLE I.—*Recording the Yearly Heights of the River Nile in the manner already described*

Year.	Height.		Year.	Height.		Year.	Height.
1849	2130	...	1859	1766	...	1869	2284
1850	2080	...	1860	2098	...	1870	2701
1851	2077	...	1861	2368	...	1871	2718
1852	2078	...	1862	2574	...	1872	2404
1853	2434	..	1863	2765	...	1873	2142
1854	2425	...	1864	2475	...	1874	2317
1855	2173	...	1865	2229	...	1875	2463
1856	2141	...	1866	2432	..	1876	2541
1857	2016	...	1867	2208	...	1877	1981
1858	1736	...	1868	2003	...	1878	2290

TABLE II.—*Recording the Dates of Maximum Height of the River Nile in the manner already described*

Year.	Date of max.		Year.	Date of max.		Year.	Date of max.
1849-50	64	...	1859-60	116	...	1869-70	96
1850-51	54	...	1860-61	80	...	1870-71	100
1851-52	63	...	1861-62	84	...	1871-72	79
1852-53	60	...	1862-63	89	...	1872-73	22
1853-54	68	...	1863-64	41	...	1873-74	33
1854-55	48	...	1864-65	33	...	1874-75	88
1855-56	43	...	1865-66	57	...	1875-76	82
1856-57	37	...	1866-67	38	...	1876-77	31
1857-58	10	...	1867-68	11	...	1877-78	40
1858-59	71	...	1868-69	52			

TABLE III.—*Recording the Water Level at Teddington in the manner already described*

Year.	Heights.		Year.	Heights.		Year.	Heights.
1860-61	315·77	...	1867-68	299·58	...	1874-75	292·91
1861-62	306·52	...	1868-69	297·21	...	1875-76	304·68
1862-63	299·83	...	1869-70	292·29	...	1876-77	299·41
1863-64	288·27	...	1870-71	278·77	...	1877-78	288·81
1864-65	294·63	...	1871-72	294·90	...	1878-79	296·32
1865-66	308·67	...	1872-73	306·10	...	1879-80	300·62
1866-67	312·11	...	1873-74	286·82			

A diagram likewise accompanies this, in which the results are graphically represented, curve (1) denoting the results of Table I., curve (2) those of Table II., and curve (3) those of Table III. In this diagram the dates of sunspot maxima are likewise indicated. From an inspection of this diagram we may perhaps deduce the following conclusions:—

1. The curve representing the heights of the River Nile and that representing the dates of maximum height are very like each other, a maximum height corresponding generally to a late date of maximum rise.

2. There is also a considerable likeness between the Nile curve and that for the River Thames.

3. There appears to be a maximum in these curves at or somewhat after the date of maximum sun-spots, but they have more than one maximum for one sun-spot cycle.

It would be extremely interesting if this comparison could be still further extended. BALFOUR STEWART

OLEO-MARGARINE

IT is now doubtless known to most people that much of what by courtesy goes by the name of butter is only very distantly related to the dairy produce which has hitherto enjoyed a prescriptive right to that appellation. If any of our readers were ignorant of this fact, the interesting and instructive statement which the Chairman of Committee, in his capacity as a private member, laid before the House during the last Session will have fully enlightened them on that point, as indeed it enlightened, and seemingly astonished, Honourable Members. During the past ten years a new industry has been created. It came into existence very quietly, and under the taint of illegitimacy, and consequently the world in general knew very little about it. Thanks, however, to the operations of Sanitary Boards, Officers of Health, and Food Analysts, it was eventually dragged out into the light of day, when, despite the circumstance that the greater part of its existence had been spent in out-of-the-way places and without the fostering recognition of authority, it stood revealed as an astonishingly well-grown and highly prosperous business. The industry in the outset was set going to manufacture a product from beef-suet to be used in the adulteration of butter, and enormous quantities of this product were made in this country and in America for this purpose. The fraud was, however, so repeatedly exposed, and convictions against grocers and others selling this adulterated butter were so frequently obtained, that the vendors were driven to so far take the public into their confidence as to declare that the product was "a butter-substitute," and hence arose the euphemism of "butterine," by which it be-

came generally known. Now these remarks are in no sense derogatory to the value of this product as an article of food. We quite agree with Dr. Playfair that "butterine" may be, and frequently is, very much better than many qualities of butter; but this fact cannot be held to defend or extenuate the practice of substituting "butterine" for butter without the knowledge and consent of the purchaser. The common-sense of buyers and sellers has practically settled this point. The manufacture of "butterine" has now reached such extraordinary proportions that we are bound to recognise it as a legitimate industry: the substance is now sold openly for what it is and on its merits, and it is perfectly obvious that it supplies a public demand. A recent report by Mr. Bateman to the Board of Trade, on the manufacture of these "butter substitutes" in the United States, throws fresh light on the subject, and the statistics which the report contains are calculated to afford a very precise idea as to the magnitude of the industry. The greater part of the substance is made in the States by the patented method of M. Mége Mouries. The process is as follows:—The beef suet, on arriving at the factory, is thrown into tanks containing tepid water, and after standing a short time it is repeatedly washed in cold water, and disintegrated and separated from fibre by passing through a "meat-hasher" worked by steam, after which it is forced through a fine sieve. It is then melted by surrounding the tanks with water of a temperature of about 120° F.; great care is taken not to exceed this point, otherwise the fat would begin to decompose and acquire a flavour of tallow. After being well stirred, the adipose membrane subsides to the bottom of the tank, and is separated under the name of "scrap," whilst a clear yellow oil is left above, together with a film of white oily substance. This is removed by skimming, and the yellow oil is drawn off and allowed to solidify. The refined fat, as the substance is now termed, is then taken to the press-room, which is kept at a temperature of about 90° F., and is packed in cotton cloths and placed in galvanised iron plates in a press; on being subjected to pressure oil flows away, and cakes of pure white stearine remain: these find their way to the candle-makers. The oil is known as "oleo-margarine": it is packed in barrels for sale or export, or is directly made into "butterine" by adding 10 per cent. of milk to it, and churning the mixture. The product is coloured with annato and rolled with ice to "set" it; salt is then added, and the "butterine" is ready for packing in kegs. The taste of "butterine" is described as being similar to that of second-class butter, but it is rather more salt; owing to the very small quantity of the characteristic fats of natural butter—the so-called "butyrin" "caprin," &c., which it contains, it lacks the flavour of high-class butter. On the other hand, as these fats are specially liable to become rancid, butterine is free from the disgusting smell and taste of the lowest class butters.

The composition of natural butter and of "butterine" may be stated as follows:—

		Butter.	"Butterine."
Water		11·968	11·203
Solids		88·032	88·797
		100·000	100·000
Insoluble Fats	Olein, Palmitin	23·824	24·893
	Stearin, Arachin, Myristin	51·422	56·298
Soluble Fats	Butyrin, Caprin, Caproin, Caprylin	7·432	1·823
Casein		0·192	0·621
Salt		5·162	5·162
Colouring Matter		trace	trace
		88·032	88·797

It will be seen that in the main "butterine" is very similar in chemical composition to butter, and its value as an article of food is probably quite as high. Indeed to some people "butterine" might possibly be more wholesome, owing to its comparative freedom from the readily decomposable fats which are apt in some cases to be specially disagreeable; for cooking purposes it may be safely averred that the artificial butter would be generally preferable, owing to the ready alteration of butyrin and its congeners by heat.

The yield of oleo-margarine is found to be about 35 per cent. of the beef caul fat employed, and its present retail price may be set down as about one shilling per pound. It is very difficult to obtain an accurate return of the production of oleo-margarine and butterine; but it is certain that in the Eastern States of America alone the yearly manufacture is not less than ten million pounds. Chicago and the West, moreover, contribute their share, and Mr. Nimmo, the chief of the U.S. Statistical Department, states that the export of oleo-margarine for the year ending June 30, 1880, was close upon nineteen million pounds. Probably this is under-estimated, for it is almost certain that considerable quantities of "butterine" passed through the Customs under the designation of butter.

The exports of oleo-margarine from the port of New York in 1879 and in the first nine months of 1880 are given in the annexed table:—

Cleared for	Year 1879.	January 1 to Sept. 30, 1880—9 months.
	Pounds.	Pounds.
Rotterdam	11,931,174	11,127,574
Antwerp	173,537	1,367,526
London	188,426	58,639
Liverpool	1,091,266	590,974
Glasgow	274,023	1,399,694
Other ports	222,438	1,215,246
	13,880,864	15,759,653

Of the $15\frac{3}{4}$ million pounds which were exported in the first nine months of 1880, $12\frac{1}{2}$ millions went to Holland, there to be churned into butterine, most of which is sent into this country. Statistics show that the import of "butterine" into this country from Holland goes on in the same ratio as the import of oleo-margarine from the States into Holland. The poor British farmer has indeed cause to grumble: for not only do the Americans, as he says, send him "acres and acres" of bad weather, and upset all his calculations as to his crops, but the 'cute Yankee and the persevering Dutchman between them give him no chance even with his dairy-produce! The world in general, however, will not complain of "butterine," provided that its composition does not differ materially from that shown by Dr. Mott's analysis given above, but unfortunately from its very nature and the somewhat anomalous position it even yet holds, it is very liable to sophistication, and the people who adulterate butter with oleo-margarine are liable to get the oleo-margarine adulterated to begin with. An ingenious American has recently sought to place butter, as he calls it, *on a soapstone basis*, by which is implied that finely-ground soapstone added to the fat will, in his opinion, make a marketable commodity! We are told, on high authority, that if we ask for bread we are not to be offered "a stone": neither are we when we ask for butter. T.

SCIENTIFIC EDUCATION IN LIVERPOOL

IN the youngest city of the Empire, which on Saturday witnessed the inauguration, by Lord Derby, of its new university, already endowed with more than a hundred thousand pounds, the public recognition of the practical value of scientific education to the community, commenced only in 1860, when Sir William Brown gave to the town the magnificent pile of buildings forming the Free Library and Museum, which at once received from the late Lord

Derby his fine natural history collection, and the Museum of Archæology and Art, formed with so much care and cost, by Mr. Meyer, of Bebington.

Previous to Sir William Brown's princely gift little seems to have been done to advance education in Liverpool since 1647, when it was entered in the records, "Ordered that two dictionaries be provyed for the use of this towne and to be chayned." In 1861 Sir William Brown stated that the Free Library and Museum would not be complete until it had attached to it a School of Science, which scheme was supported by the then Mayor, Mr. S. R. Graves, and the school was opened in October of that year by Lord Granville, then Lord President of the Council, supported by the Right Hon. W. E. Gladstone and Sir William Fairbairn, president of the British Association for that year. The school was affiliated with the Museum and Library Committee of the Corporation, and at present contains no less than 801 students, the largest number in any science school in the kingdom. Last year it obtained three scholarships at the Normal School of Science, South Kensington, and four Whitworth scholarships, whilst 81 per cent. of the students passed the Government Science Examinations, winning four Queen's medals and 233 Queen's prizes, and a Government Grant of 694*l*. In 1865 a period of depression occurred, which ceased in 1868, when Messrs. S. Leigh-Gregson and T. J. Moore, the indefatigable honorary secretaries, made vigorous efforts to improve the attendance, which was most successfully effected by doubling the fees, since when the marked prosperity has been unbroken, and all that is wanted is a central building instead of the present twelve centres of instruction.

A very valuable outcome of this School of Science are the free lectures, given at the expense of the Liverpool Corporation every winter in the Free Library and Museum, on subjects connected with the objects and specimens in the building. The programme for the present session includes numerous lectures on purely scientific subjects; amongst the lecturers are Messrs. Clements Markham, Lant Carpenter, De Rance, Professors R. S. Ball and Campbell Brown.

In addition to the Science School affiliated with the Corporation are the Liverpool Science and Art Classes, established in 1870, through the energy of Mr. J. Samuelson. There are no less than fifty-one classes held in seven centres; the numbers of students in science are steadily increasing, and by arrangement with the Liverpool School Board their pupil-teachers are allowed to attend the science classes, so as to qualify them for science-teachers. In some cases laboratories have been erected at the Board schools, and the School Board have appointed a Science Demonstrator with two assistants of their own. The boys so taught have recently been examined by Prof. Forbes, of the Andersonian University, Glasgow, who reports very favourably of them.

Three years ago it was realised that the existing institutions did not satisfy the requirements of high education in Liverpool, and it was determined to found a University College, in connection with the Victoria University, and in this comparatively short time no less than seven Professors' Chairs have been endowed, with ten thousand pounds each, several chairs being founded by single donors, amongst whom is Lord Derby.

The Council of the College having no large funds to expend in the erection of imposing buildings, have been fortunate to receive from the City Council a large building standing in its own grounds at Brownlow Hill, a site on the brow of the hill 200 feet above the sea, overlooking the public buildings of Liverpool and the broad channel of the Mersey; in the city, yet removed from its traffic and turmoil. The building was originally erected at a cost of 20,000*l*.; it contains a rectangular centre with two wings; the solidity with which it was built has enabled Mr. Waterhouse to throw down the compartment walls of the wings, and to convert them into two lecture theatres, holding 150 students each, while the body of the buildings form council, professors' and class rooms, whilst other rooms have been fitted up as libraries, natural history, and physical laboratories, and engineering and drawing rooms. There are at present no chemical laboratories, but those of the adjacent medical school being available they are hardly required. The scientific chairs at present filled are those of Physics, Biology and Geology, and Chemistry, held by Professors Lodge, D.Sc., Herdman, D.Sc., F.L.S., and Campbell Brown, F.C.S. respectively. It is to be hoped ere long the wide range of knowledge covered by such sciences as biology, botany, and geology will be separated into at least two chairs, especially as the proximity of the Lancashire and Welsh coalfields render it important that Practical Geology and Mining should find a place amongst the College Chairs.

At the inaugural ceremony on Saturday Lord Derby presided, and showed from the sums that were still coming in that there is likely to be no lack of funds. Among other things he said: "We live in changing times, but democracy appreciates education, and especially appreciates science, and I think the scientific foundation is pretty safe not to be disendowed whatever happens. Let me add only this. Over and above its special educational work our college will do two things. It will be the centre of local patriotism, the means by which local public spirit may freely display itself, and it will give fresh evidence, if evidence is needed, that commerce and culture, so far from being antagonistic, are natural allies. They were so in Athens, they were so in Alexandria, they were so in the Italian Republics of the Middle Ages, and I do not think that a probably busier existence and a certainly smokier atmosphere constitute any reason why they should not be so here likewise."

Prof. Rendall, M.A., in delivering the inaugural address, said:—"The effort inaugurated that day was but one of many, each one wearing, indeed, its distinctive features, but all alike. What meant the simultaneous stir in Birmingham, in Bristol, in Leeds, in Nottingham, in Sheffield? What meant a host of cognate efforts in country towns and in the metropolis, too numerous to recapitulate? What meant the sudden expansion in want of a college whose fate and trial it was to wait long and work obscurely, sustained rather by belief in its mission than by reassurances of success? It was easy to say that the forwardness of founders was out of proportion to the zeal of students. As a matter of fact, founders' munificence has met with quick response, and five times out of six it is lack of funds, not lack of classes, that has hindered progress or even entailed defeat; and for predicting a like conclusion there were ample grounds. For primary education in England efficient provision had been made; of secondary and higher education the supply was sparse and capricious; while academic training remained the monopoly of the privileged and the wealthy. Unless the middle classes looked to it they would shortly find their children starting the race of life less well equipped for the inevitable struggle than those who in wealth and social standing have occupied a lower place."

Certainly the Liverpool College has made a most promising start; and considering the wealth of the city, there is no reason why, in a very short time, it should not be in perfect working order.

BJERKNES' HYDRODYNAMIC EXPERIMENTS

IN NATURE, vol. xxiv. p. 360, were described in general terms the very interesting experimental researches of Prof. Bjerknes, of Christiania, which excited so much attention at the late Electrical Exhibition at Paris. Our readers will remember that the main point in those re-

searches was the imitation of the phenomena of magnetic and electrical attraction and repulsion by analogous attractions and repulsions produced between pulsating or vibrating bodies immersed in liquid. The extreme importance of such experiments in hydrodynamical theory was so well pointed out by Prof. George Forbes in the former article, that nothing need be said here in that respect. The present article is confined to a concise description of the apparatus of M. Bjerknes, and of the results obtained by its means.

Fig. 1 depicts the fundamental piece of apparatus for showing the action between two pulsating drums or tambours, A and B. These tambours consist of metal cups covered with an elastic membrane. Each tambour communicates by a tube with an apparatus by means of which

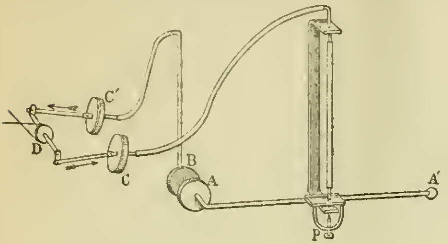


Fig. 1.

the elastic membrane is set in regular pulsation. A pulley, D, driven by a band from a multiplying wheel, works two small cranks whose rotations are converted into rectilinear movements by connecting-rods attached to two other tambours, C and C′; the latter serving as pumps to alternately compress and rarefy the air in the tubes which communicate with A and B. Fig. 2 shows the construction of a single pulsating tambour. When air is compressed into it the membrane is forced outwards as at C, when the pressure is withdrawn the membrane is drawn in as at D. Returning to the particular apparatus of Fig. 1 the result of setting the adjacent tambours in synchronous vibration when the whole apparatus is immersed in water, is as follows. If the tambours are arranged so that the movements are in similar phases

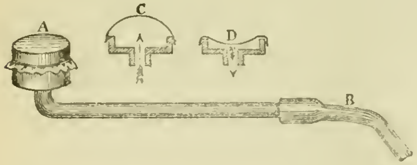


Fig. 2.

they *attract* one another; if in opposite phases they *repel*. This is exactly the inverse of what occurs for magnetic poles or electric charges, where similars repel one another and dissimilars attract one another. The tambour A is mounted upon a lever capable of turning upon a pivot at P, and balanced by a counterpoise at A′. The connection with the pump C is made through a vertical tube of india-rubber which permits of limited rotation about a vertical axis. The tambour B is held in the hand at a convenient distance, just as one may hold in the hand a magnet to show its action upon a balanced compass needle.

A second fundamental piece of apparatus is the oscillating sphere shown in Fig. 3. To a pulsating tambour is fixed a small plate of metal, C, bearing a stiff wire terminated by a small ball, A, and supported by a metal guide. The oscillations executed by such a ball when pulsations of air are directed into the tube D, are of course rectilinear displacements to and fro. Such an oscillating sphere presents at opposite sides opposite phases of displacement. Accordingly if the tube D be connected with the pumping apparatus, and a tambour, such as that just described, communicating with the other pump, be held near the sphere A, it is found that the effects are of two opposite kinds, according to the position of the tambour. The oscillating sphere resembles then a magnet in having two poles of opposite properties. These figures are from sketches furnished some months ago by M. Bjerknes. His apparatus, as shown in the Paris Exhibition, included a more powerful means of producing the pulsations. In Fig. 4, which shows the tank and the collection of small pieces of apparatus, the driving gear of the pumps is not shown; but the pumps themselves are drawn in the lower right-hand corner of the figure, and consist of two small metal cylinders fitted with pistons; the connecting gear being so arranged that their movements can be made at will either in similar or in opposite directions. In the figure the fundamental experiment of the mutual action of two pulsating tambours is being shown. Two pulsating elastic spheres show similar results, but are less easy to manage. Some of the other portions of apparatus comprised in the collection are separately shown in Fig. 5. Of these the first is a double tambour whose two faces execute pulsations of similar phase. The second is a double tambour, the two chambers of which communicate separately with the two

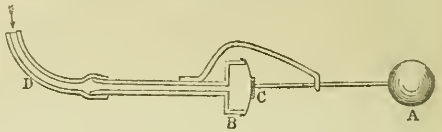


Fig. 3.

pumps, and in which therefore the two membranes execute movements in opposite phases. Thirdly, we have two spheres, of which one (on the left) is mounted so as to execute horizontal oscillations; the other (on the right) to oscillate vertically. It is possible to mount the oscillating spheres, either singly, or in pairs, upon horizontal axes, in which positions they act like mounted compass needles, following the action of another pulsating body; but always with the inversion of phase alluded to previously, *like* phase producing attraction; *unlike*, repulsion.

In the foregoing cases the pulsating and oscillating bodies act on one another, producing (inversely) mutual actions and reactions as the poles of magnets do. M. Bjerknes has also succeeded in imitating the phenomena of *diamagnetism* and of *magnetic induction*.

Diamagnetism is imitated by making the pulsating bodies act upon objects lighter than water suspended within the liquid by a thread attached to a weight. A small ball of cork thus suspended is repelled from both a pulsator and an oscillator in whatever phase the latter may move. Temporary induced magnetism is imitated by the behaviour of balls of some material heavier than water suspended from a float. Such a body is attracted by a vibrating or pulsating body. In the nearest corner of the tank of Fig. 4 are a pair of heavy bodies hung to threads for this very experiment. A little further to the right is shown a support from the top of which is suspended a little cylinder of heavy metal. When the pulsating tambour is held near this it turns round and points towards the tambour as a suspended piece of soft iron does towards a magnet pole. The same support carries a

lower arm, from which a thread passes up to a cylinder made lighter than water. This cylinder sets itself broadside to a pulsating tambour, behaving as a piece of bismuth or other diamagnetic body when placed between the poles of an electromagnet. Here the importance of the *medium* in determining by its own density the move-

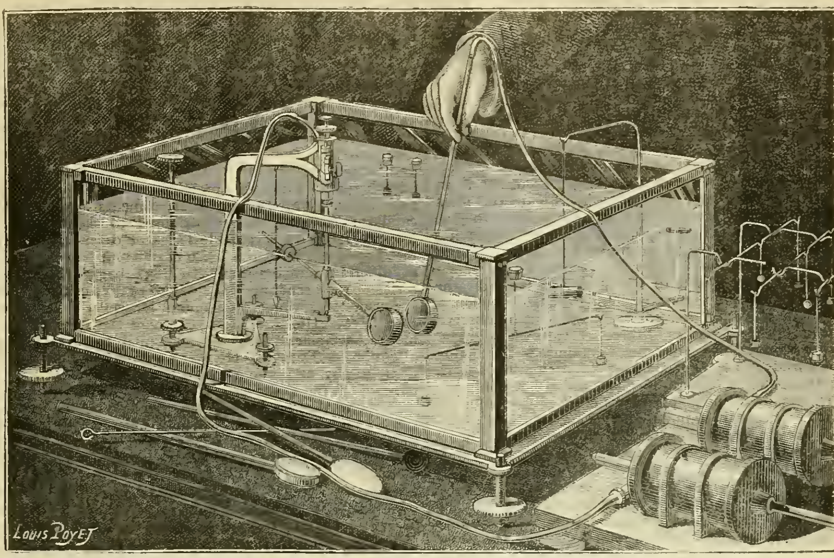


FIG. 4.

ments of the body acted upon, is obvious; and it furnishes an admirable commentary on the views of Faraday and Becquerel on the relation of the magnetic powers of the surrounding medium to the magnetic or diamagnetic properties of bodies.

This particular series of experiments is most instructive;

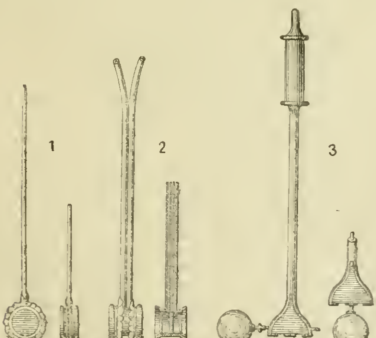


FIG. 5.

and deserves a little further elucidation. If a small heavy ball hung to a float is acted upon by two pulsating tambours whose phases are opposite, it is a question in *which* phase the little ball shall vibrate. Eventually it takes up that of the more powerful pulsation, if they be of unequal power, or of the nearer one if they are unequally distant. The effect is like that on a small suspended bit of iron between two magnet poles of unequal strength, or at unequal distances. Now when a small *heavy* body is set

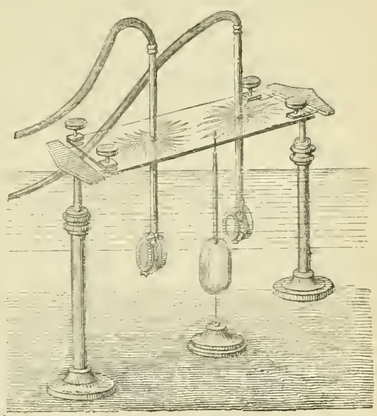


FIG. 6.

pulsating by motions in the surrounding water it moves through a *less* amplitude than the water would have done in its place; for if it receive the same kinetic energy from

the medium, its own mass being greater, its velocity will be less; its motions will therefore, relatively to the pulsator that is acting on it be in the same phase, and it will be attracted. On the other hand a body lighter than the surrounding water vibrates with a greater amplitude; and being, relatively to the pulsator, in an opposite phase, will be repelled.

Lastly, we give a drawing of the ingenious indicator by which Prof. Bjerknes has succeeded in tracing the lines of force in the midst of the medium through which such actions as these are propagated. For this purpose a light hollow metal egg-shaped vessel held by a thin flexible steel wire to a heavy foot is placed in the tank. It takes up, both in magnitude *and direction*, any oscillating movement which may be going on at that part of the liquid in the tank where it is placed. If, as in Fig. 6, it is desired, for example, to investigate the lines of hydrodynamic force in the "field" between two pulsating tambours, we may explore these lines by placing the indicator at different positions and observing the direction in which it oscillates. A camel's hair pencil charged with colour fixed to the summit of the indicator serves to inscribe a trace of the line of oscillation upon a sheet of glass placed above. It is singular to observe with what fidelity the lines of force of various magnetic fields are reproduced in the figures obtained in the analogous hydrodynamic conditions. An oscillating sphere shows two poles; a pulsating sphere radial lines only.

Even the phenomena of the "field" of force due to electric currents can be imitated by Prof. Bjerknes' apparatus. A cylinder rotating round its own axis with an alternately directed rotation represents an electric current. Near such an excitor an indicator in the liquid vibrates tangentially to the rotation. The remarkable magnetic figures produced by the mutual action of two currents upon one another are perfectly reproduced by the mutual actions (on an indicator) of two rotating cylinders; while the spiral systems of lines of force produced, as Prof. Silvanus Thompson discovered (see NATURE, vol. xix. p. 83), by the mutual action of a magnet pole and of a current traversing it are exactly reproduced by Prof. Bjerknes' indicator under the influence of an apparatus which pulsates and rotates synchronously. The most extraordinary thing about Prof. Bjerknes' researches is that they are all the result not of haphazard experiment, but of careful and abstruse calculation. In 1865 he began the investigation. By 1875 he had perceived that the calculated motions were such as would have direct analogies with the phenomena of permanent magnets. Toward 1879 he found that these analogies might be extended to the case of magnetic induction. Then, and not till then, were the beautiful pieces of apparatus made, by means of which these remarkable previsions have been verified.

JOHN WILLIAM DRAPER

JOHN WILLIAM DRAPER, M.D., LL.D., President of the Medical and Scientific Faculties of the University of New York, who died January 4, 1882, was an Englishman, having been born at St. Helens, near Liverpool, on May 5, 1811. He was therefore in his seventy-first year. Up to the age of twenty-two he was resident in his native country, receiving his education, first under private tutors, and afterwards studied chemistry in the University College, London, then known as the University of London. In 1832 he emigrated to the States, and continued his studies at the University of Pennsylvania, where, in 1836, he took the degree of M.D. Meantime his talent for original research had manifested itself in the production of several memoirs, which appeared in the pages of the *Journal* of the Franklin Institution. The first of these (published in 1834) was "On the Nature of Capillary Attraction"; whilst a second was devoted to a discussion of the most eligible method of constructing galvanic batteries of four elements. In 1835 he published an account of some experiments made to detect whether light exhibits any magnetic actions. Several branches of the science of electricity subsequently claimed his attention. In 1839 he wrote a memoir, which afterwards was reprinted in the *Philosophical Magazine*, "On the Use of a Secondary Wire as a Measure of the Relative Tension of Electric Currents." It is instructive to observe in this memoir how Draper's exact mind revolted against the misuse, by writers on electricity, of the words "tension" and "intensity"; and, though he himself employed both terms, he carefully distinguished between them, using "tension" for what we now call "electromotive force," and "intensity" for the "strength of the current," agreeing therefore with the practice of many continental authorities. He also made experiments upon electro-capillary motions, and contributed to the science of thermo-electricity, a valuable series of determinations of the thermo-electromotive force of different pairs of metals at different temperatures. In 1837 began the notable series of researches upon the nature of rays of light in the spectrum, with which the name of Draper will always be associated. His paper that year bore the title "Experiments on Solar Light," but it failed to attract much attention in Europe. He was now devoting himself to photography and photo-chemistry with great zeal. His paper "On the Discovery of Latent Light," in 1842, dealt with the images produced by rays of light which are only subsequently developed by some chemical reaction—a process with which the art of photography has made us familiar, but which was then a curious and novel phenomenon. It was Draper who first discovered that in the ultra-violet part of the spectrum there are absorption bands like the Fraunhofer lines in the visible part of the spectrum. To enumerate the works which proceeded from Draper's pen upon the chemical and physical properties of the ultra-violet, or as he styled them, *tithonic* rays, would be inadmissible here. Suffice it to say that the greater part of the fifty memoirs mentioned in the Royal Society's Catalogue related to this subject, and the most important of them are to be found reprinted in his "Scientific Memoirs," published in 1878. In this volume may be found the pregnant suggestion for a standard of white light for photometry of a piece of platinum foil of given size and thickness, raised to a white heat by an electric current of specified strength. To guard against fusion he suggested that an automatic short-circuiting apparatus should be constructed by some "skilled artificer." He thus exactly anticipated Edison's first incandescent lamps: though the satisfactory standard of white light appears to be as far off as ever.

The latest papers Draper published were entitled "Researches in Actino-chemistry," and treated of the distribution of heat and of chemical force in the spectrum. They appeared in 1872 in the *American Journal of Science* and in the *Philosophical Magazine*. During these years of work Draper held important appointments, first in Hampden-Sidney College, Virginia, where he was Professor of Chemistry, Natural Philosophy, and Physiology, and afterwards (1839) in the University of New York, where he was Professor of Chemistry and Natural History, a post modified two years later into that of Professor of Chemistry in the Medical College of the University. In addition to the original memoirs enumerated above Dr. Draper wrote several valued text-books of science; a Text-book of Chemistry in 1846, and a Human Physiology in 1856, both of which works went through several editions.

Dr. Draper's literary activity manifested itself however in other directions, and he has left an enduring mark in literature as a philosophic historian of no mean merit. The "History of the Intellectual Development of Europe," published in 1862, has been translated into all the current

languages of European nations. His "History of the American Civil War," a work which appeared between the years 1867 and 1870, when the bitter animosities of the strife were still raging, is distinguished by an impartiality of tone and a philosophic elevation remarkable in a historian, and trebly remarkable in one who wrote in times so little remote from the stirring events recorded. In 1874 Dr. Draper published a "History of the Conflict between Science and Religion," a work which attracted some notice, and for which a preface was written by Prof. Tyndall to introduce the work to English readers. Though unequal to the preceding works in merit, and marred by assumptions that detract from its value, it nevertheless showed great vigour of intellect and philosophic power.

Dr. Draper leaves two sons, both of whom are known to science: Prof. John Christopher Draper, whose works on Physiology are well known on both sides of the Atlantic, and Prof. Henry Draper, whose labours in spectrum analysis, and on the construction of silvered glass specula for telescopes, are too well known to require mention. Dr. Draper leaves behind him an honourable and well-won fame; and his removal leaves a gap amongst the older generation of American scientific men which a few years ago would have been irreparable. Happily amongst the younger generation there are many whose talents have amply qualified them to step into the gap. In the breasts of all who desire the progress of science, regret for the loss they have sustained cannot but be mingled with satisfaction that the mantle falls upon the worthy shoulders, not of one successor, but upon a crowd of apt followers in the footsteps of the departed veteran.

NOTES

All but Fellows of the most recent date will hear with regret of the death, on Saturday, of Mr. Richard Kippist, who for nearly fifty years acted as librarian to the Linnean Society. Born in 1811, he was, when quite a lad, clerk in the office of Mr. Joseph Woods, F.L.S., architect, and an accomplished botanist. His taste for botany either originated or was acquired when under that gentleman, with whom he travelled, and afterwards assisted in the publication of "The Tourist's Flora" Mr. Woods leaving London for Lewes, Mr. Kippist, in February, 1830, entered the service of the Linnean Society, then in Soho Square. On Prof. Don's (the librarian's) death in 1842, Mr. Kippist, then an Associate of the Society, was elected by the Fellows his successor. Mr. Kippist contributed various botanical papers to the Linnean Society, which were published in their *Proceedings* and *Transactions*; the most important of which was that on the existence of spiral cells in the seeds of *Acanthaceæ*. He was an original Member of the Royal Microscopical Society, and an Associate of the Royal Botanical Society, Regent's Park. For a number of years Mr. Kippist suffered from asthma and chronic bronchitis, which materially affected his earlier active habits. He retired from office in 1880, after fifty years' service. He identified himself completely with the Society and its officers, securing the esteem of successive presidents and Councils, and the respect of succeeding generations of Fellows. Latterly he carried his methodical habits and his zeal for the Society's welfare to a degree that might have been distasteful to those younger Fellows who were not acquainted by experience with his life-long, single-minded devotion to the Society. These qualities, however, were duly appreciated by those conversant with the affairs of the Society, and whenever opportunity served, fit expression was made of the sense entertained of the value of his services, so that when, a year or two since, Mr. Kippist's failing health no longer enabled him to discharge his duties, the graceful action of the Council in allowing their old servant to retire on full pension was universally approved of by the Fellows. Mr. Kippist's complete devotion to the duties of his office left him little leisure for other work, while his modest, retiring habits led him to shun society. His published memoirs are therefore few in number, but they are marked with the scrupulous fidelity so characteristic of the author. They relate exclusively to botanical subjects.

Preparations for the forthcoming Electrical Exhibition are drawing their slow length along. The only really complete exhibit at present is that of the Postmaster-General, and this, as an historical exhibit, is very good indeed. The South-Eastern Railway also made a very good show, and the Electric Light and Power Generator Company are in position; but much remains to complete the Exhibition, and it will be another fortnight before it can be considered ready for inspection. On the evening of the 17th inst. the Edison lamp was shown in operation. The Concert Room was illuminated by over 200 of these pretty little lamps, each of which gives 16 candle-power. An extremely handsome chandelier was erected in the centre of the room, and its effect was very brilliant. The steadiness and uniformity of the Edison incandescent lamp is very marked, and it compares in this respect very favourably with the Swan and the Lane-Fox lamps. A large party gathered together and dined between the rays of this brilliant light, but, as it very often happens under such circumstances, an accident occurred which put out the lights for nearly an hour. This was, however, the fault of the engine, the safety-plug of which had blown out. The Exhibition generally produced a very favourable impression.

The Geographical Society have now on exhibition a relief map of the equatorial region of Africa, constructed within the last twelve months for Col. Grant by Mr. James B. Jordan. The area included in the map is nine times greater than the British Isles, and nearly nine times less than the total area of Africa. It was therefore considered necessary to adopt the horizontal scale of one inch to twenty-five miles, and the vertical scale of one inch to five thousand feet. This gives an exaggerated idea of the mountains, but in relief maps this cannot be avoided if we wish to show the principal features of a country. The construction of the relief was a work of nearly twelve months. An accurate map had to be made on a given scale from carefully collected data; this was transferred to clay by a kind of pantagraph of Mr. Jordan's (senior) invention, a cast taken, and the present relief map constructed of papier-maché. There were several reasons for making it of this material: one, its lightness would enable it to be hung like a picture; another, the impossibility of its cracking and chipping as clay does; it represents nature better, and it can be easily repaired if the housemaid pokes a hole through it with her brush. When looked at in the light striking upon one side, the aspect of Africa in the interior is no longer the barren waste of the maps of fifty years ago; the interior, with its deeply-set lakes and the swelling lands round them, looks as if it could not but be inhabited by human beings, and it is so. All the data as to altitudes, latitudes, longitudes, and sections were taken from the accounts of the several travellers who have discovered or visited the interior, and Mr. Jordan has, in his well-known painstaking and conscientious manner, followed out the observations of these authors in a most accurate manner. Though it is clear to all that the model cannot be sufficiently correct where no observations had ever been made, still with his skilful hand and artistic taste, Mr. Jordan has produced a relief map which would bear comparison with any in Europe.

We learn that the report that the bodies of the missing *Jeannette* men have been found on Wrangel Land is erroneous; they are no doubt those of part of the crew of the whaler *Vigilant*. Several of the members of the expedition have reached Jakutsk. The French journal *L'Exploration* publishes an extraordinary letter purporting to have been received from one of the members

of the expedition, describing the wandering of the ice-bound *Jeannette*, the horrors and beauties of an Arctic winter, and other features, which must be the product of a French imagination. Has some wag been imposing an extract from one of Jules Vernes' works on our guileless contemporary? Of course no credence is given to the authenticity of the letter at the *New York Herald* Office; it seems clear that no such letter could have reached Europe yet, and certainly there was no Frenchman on board the *Jeannette*.

AMONG the special articles in the *Annuaire* of the Bureau des Longitudes (Paris, Gauthier-Villars) for 1882 are a historical sketch of the development of astronomy, by M. Faye; on the intra-Mercurial planet, by M. Tisserand; and M. Janssen's pape. on his photograph of Comet *b* 1881, with copy of the photograph. From the same publishers we have the *Annuaire* of the Montsouris Observatory, which is largely devoted to meteorology. Besides various tables for the use of agriculturists, and a variety of meteorological tables, we have several chapters discussing in detail agricultural meteorology; a meteorological *résumé* of the agricultural years 1873-81; chemical analyses of air and water; general investigation on atmospheric Bacteria; purification of sewage, &c.

A MOVEMENT is on foot in the United States, we learn from the *Daily News*, for securing the adoption of a uniform standard of time throughout that country. Considerable disagreement exists, however, as to the best standard to be adopted—that is, whether Washington or New York, or Pittsburg or Greenwich time shall be observed. The strongest claim appears to be put forward in favour of Washington, not only as being the capital city, but as possessing the well-known Naval Observatory, which, being the only national astronomical institution, should, it is contended, do for the United States what Greenwich does for Great Britain. The Signal Service Bureau proposes to utilise its system of telegraphic communication for distributing accurate time signals to all important points.

A REMARKABLY rapid disappearance of a flaming solar protuberance was observed last August by Herr Spörer, who describes the phenomena in the *Astronomische Nachrichten*. About 5 p.m. on the 2nd this protuberance was observed with broad base and intense luminosity, reaching a height of about one minute, while further out it appeared as a loose, less luminous cloud; the entire height being about four minutes. Herr Spörer, having passed to another part of the sun's disc for about five minutes, was surprised to find on return that in this short time the whole lower part of the protuberance had completely disappeared, while all that remained of the upper part was a few small isolated clouds.

WE have received several of the sheets of the "Enciclopedia Popular Ilustrada de Ciencias y Artes," which is being pub. lished in Madrid under the care of Mr. Frederick Gillman, Mining Engineer there. Mr. Gillman seems to be doing most of the work himself, and the undertaking is a formidable one. It is, however, highly creditable; the text is evidently based on the best existing English and German Cyclopædias, and the abundant illustrations are nearly all that could be wished. When one considers the state of education in Spain, Mr. Gillman's attempt to diffuse elementary instruction in this form must be regarded as a really philanthropic undertaking, to which we wish the greatest success.

THE colour of water forms the subject of a recent inaugural dissertation by Herr Boas, in Kiel (*Wied. Beibl.* No. 11). After reviewing previous observations, he describes his own experiments, the first of which were qualitative, sunlight being sent through water in a zinc tube about 46 feet long, closed with glass plates. Distilled water thus gave a fine deep blue-green colour: the red was quite gone, the yellow feeble, while the maximum brightness was in the green. Water of the Kiel supply let no light through the length of the tube stated; with half the length it appeared deep orange; blue and green failed. In his quantitative experiments the author illuminated two screens with the same light-source (sodium light or a gas flame), before which was placed red glass, or sulphate of copper solution. The light from one screen went through water in a tube; that from the other along the tube outside. Both beams were brought into a position for comparison by means of total-reflection prisms; the screens were shifted till equal brightness was reached, and from their position the coefficients of absorption could be approximately inferred. The decrease of absorption towards the blue in the case of distilled water is thus clearly shown Herr Boas further studied the polarisation of the light issuing from the water, by depolarising it. It was weakly polarised in a plane passing through the sun and the direction of the beam. Experiments with a view of detecting fluorescence had a negative result.

ON Saturday afternoon a series of interesting experiments on a practical scale were carried out in the grounds of the Crystal Palace with asbestos paint, in order to test its qualities as a protective covering against fire. This paint is a new and special preparation of asbestos, and is being introduced by the United Asbestos Company, of 161, Queen Victoria Street, E.C. The asbestos in a finely divided state is mixed with a fluid material, and is used in a similar manner to other paints. Unlike them, however, it is uninflammable, and not only so, but is capable of communicating this valuable attribute to such substances as it may be applied to. This applies alike to cotton fabrics and to timber or other inflammable materials used for constructive or decorative purposes. Hence its great value in connection with theatrical properties and appliances, especially those connected with the stage arrangements. Several experiments were made, all of them reported completely successful so far as proving that the paint is a powerful protection against conflagration.

AT the coast it may readily be observed that a red coloration is very common among invertebrate animals, and even fishes. And according to M. de Merejkowski (*Compt. rend.* Paris Academy of Sciences), even the animals coloured yellow, brown, green, and black have always a scarlet red pigment, which in their case is hidden by others. The red pigment, he finds, is always the same substance, viz. that known as *tetronerythrine*; he has verified its presence in 104 species (invertebrates and fishes). The question arises, What is the physiological *rôle* of this widely expanded substance? The author finds evidence that it corresponds to hæmoglobin in higher animals; serving for cutaneous respiration by virtue of its great affinity for oxygen. Thus, as regards distribution in organs, wherever oxygen has to be largely consumed by the tissues, there tetronerythrine is abundant. This is illustrated by skin tissues in immediate contact with the oxygen of the water; by the organs of respiration (*e.g.* in sedentary annelids, the tetronerythrine is concentrated in the branchiæ, the rest of the body having only traces); by muscles, and such an organ as the muscular foot of Lamellibranchiates. Next, as to distribution in the animal kingdom: sedentary animals are often redder and have more tetronerythrine than errant animals; the latter, which by constant change of place, are always in water holding plenty of oxygen, not having the same need of a special substance to increase the oxygen absorbed by the tissues. Then the fact that tetronerythrine occurs by preference in invertebrates, where hæmoglobin is wanting (and only exceptionally in higher animals), points to similarity of function in these substances. It is further pointed out that animals provided with yellow cells (parasitic algæ), which are proved to produce free oxygen in the tissues, are without tetronerythrine, or have very little of it.

THE following appointments to the staff of the Normal School of Science and Royal School of Mines have been made by the

Lord President of the Council:—J. F. Main, M.A., D.Sc., Professor of Mathematics and Engineering at University College, Bristol, Assistant Professor of Mechanics and Mathematics; F. Orpen Bower, B.A., Demonstrator of Botany at University College, London, Lecturer on Botany; Frank Rutley, F.G.S., Assistant Geologist on H.M. Geological Survey, Lecturer on Mineralogy; J. Russell Smith, Instructor in Mechanical Drawing.

THE Lord President of the Council has appointed Mr. Haddon, Professor of Zoology in the Royal College of Science, Dublin, Assistant Curator in the Natural History Department of the Dublin Science and Art Museum.

MR. J. M. SCHUVER has forwarded to *Petermann's Mittheilungen* an account of his proceedings since his departure from Cairo last January. He reached Khartum on March 19, and leaving again on April 4, he travelled by way of Senaar to Famaha (Fazogl), where he arrived on April 28. Fadassi was reached on June 12, and on the way Mr. Schuver ascertained that the Termat affluent of the Blue Nile rises in the Sori Mountains, west of Fasuder, and not half a degree to the south near Belletafa, as has been supposed. There is a stream called Turmat near Belletafa, but it is an affluent of the Jabus. At Fadassi Mr. Schuver met with a series of misfortunes, and was himself taken seriously ill with fever. On July 30, however, he was able to start on a trip to the south, and after thirty-eight days' travelling returned to Fadassi. During this journey he explored the Amam country, which is watered by two affluents of the Jabus, as well as that of the Legha Gallas; he also proved that the Jabus rises a degree further south than is shown to be the case on Petermann's map, and that the great Lake and River Baro are situated a degree further to the south of Fadassi, and he defined the exact line of water-parting between the two Niles as far as the 8th parallel. Mr. Schuver intended to start from Fadassi on January 1 of this year to explore the vast unknown regions down to the equator, but in so doing he will have to make a considerable *détour* to the west to avoid the country of the Legha Gallas, from which in his previous visit he escaped with great difficulty.

A PRIZE of 5000 lire (say 190*l.*) is offered by the Reale Istituto Veneto "for the best history of the experimental method in Italy." The application of this method to the physical sciences is chiefly to be expounded, with special regard to all that is noteworthy in the four centuries from the beginning of the fifteenth to the end of the eighteenth, including the discovery of the Voltaic pile. Some account is also required of the progress and rapid development of the economic and social sciences by means of the experimental method. Memoirs must be sent in before the end of February, 1885. Foreigners may compete, and the language may be Italian, Latin, French, German, or English.

MAJOR W. GWYNNE HUGHES, Deputy Commissioner of British Burma, has just published a useful little volume on the hill tracts of Arakan, of which he was lately superintendent. Two of its sections are devoted to their history and ethnology, and the volume is accompanied by a map (scale 32 miles to an inch) of the eastern frontier of British Burma.

PROVINCIAL museums have begun to appear in Russia, and we learn that the Natural History Museum opened last week at Yaroslavl already contains 50 skulls, 250 birds, 500 birds' nests, with eggs, a complete collection of seeds of all wild plants, 1200 fossils, and 5000 minerals, together with interesting collections of useful and noxious insects and plants, and a collection of plants classified according to the soils they grow upon.

NUMEROUS antique objects have recently been found in an ancient German tomb near Lindelbach (Franconia), and have been presented by the proprietor to the University of Würzburg. They all date from the Bronze Age.

COL. VENUKOFF, now in Paris, has written to the Geographical Society there, stating that the exploration of Turcoman Land by Russian topographers is progressing rapidly, and that Lieut. Loukiomov has proceeded as far as Seraks on the banks of the Tejent River. At the same sitting letters have been read from the French exploring party in Central Africa. They had been written from Bokhara to M. Bischoffsheim, who, not confining his assistance to astronomers, has been the principal patron of the expedition. A later telegram to M. Bischoffsheim states that the party had arrived at Krasnovodsk.

THE recently published volume of the "Materials for the Geology of Caucasus" contains a paper, by M. Batsevitch, on the naphtha-valley of the Apsheron peninsula. Towards the north, east, and south the valley is bounded by a *cirque* of Pliocene rocks of the Aralo-Caspian formation, and towards the west by the mud-volcano Bog-Boga. The valley itself, three miles long and three miles wide, is filled by naphtha-bearing formations, and it contains the richest wells of Balakhan and Sabuntchi. Towards the west it joins the great crevice, or rupture of rocks, which runs west and east from the mud-volcano Saghilpiry. As to the origin of the Apsheron naphtha, the author considers it a result of gaseous emanations from submarine mud-volcanoes of the post-Pliocene period.

THE telephone has penetrated even to Russian Turkestan, as we learn that Samarkand is in telephonic communication with Katty Kourgan, forty-four miles distant.

THE death is announced, at the age of ninety years, of the widow of the late Sir William Fairbairn.

ACCORDING to Mr. G. Levison the light emitted by the little fire-flies that abound in the neighbourhood of New York exhibits, when examined in the spectroscope, a peculiarity worthy of note. The blue and violet rays are wanting, and those of least refrangibility are predominant. In the light emitted, of the various preparations of phosphorus itself very little can be discovered except green rays.

PROF. KONRAD KELLER, of Zürich, the well-known zoologist, is about to undertake a scientific exploring tour to the shores of the Red Sea. The journey will last several months.

GLARUS has been the scene of another great landslip. A mass of rock 300 metres high has fallen from the summit of the Rothrisi, swept away a forest above Ennenda, devasted some valuable land, and destroyed the roads. It fortunately missed the village, and no lives were lost. There being nothing in the weather to account for the many landslips that lately have occurred in Switzerland, the phenomena are ascribed in great measure to the frequency of slight earthquake shocks, twenty-one of which have been observed in various parts of the country since the beginning of December.

THE *American Naturalist* announces the death, at the age of twenty-seven years, of Mr. J. D. Putnam, President of the Davenport Academy of Natural Sciences, the success of which is largely owing to Mr. Putnam's exertions. Mr. Putnam had devoted considerable attention to entomology.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus radiatus* ♀) from India, presented by M. Kessels; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. John Verinder; three Young Otters (*Lutra vulgaris* ♂ ♂ ♀), British, presented by the Reading Angling Association; seven European Scorpions (*Scorpio europæus*) from Nice, presented by Mr. T. D. G. Carmichael, F.Z.S.; two Macaque Monkeys (*Macacus cynomolgus* ♂ ♀) from India, two Arabian Gazelles (*Gazella arabica* ♂ ♀) from Arabia, deposited.

OUR ASTRONOMICAL COLUMN

SOLAR PARALLAX FROM OBSERVATIONS OF MARS.—In an appendix to the Washington Observations for 1877, Prof. Eastman, of the U.S. Naval Observatory, deduces "a value of the solar parallax from meridian observations of Mars at the opposition in 1877." In September, 1876, a circular was addressed from Washington to the principal observatories in both hemispheres, inviting co-operation in systematic meridian observations of Mars at the close opposition of the following year, and in response series were received from the Cape of Good Hope, Melbourne, Sydney, Cambridge, U.S., Leyden, Kremsmunster, and San Fernando, but Prof. Eastman excludes from his investigations the observations at the last two observatories, in the absence of sufficient details as to the methods and instruments employed. In the circular it was proposed to follow virtually the method of observation adopted at Pulkowa, by Prof. Winnecke in 1862, but it is stated, "The prescribed method of observing was *fully* carried out at only *two* stations and *partially* at one. Where the plan of the circular was strictly followed, the character of the work was decidedly superior to that where the directions were disregarded."

The results of the comparisons are thus given :—

	Sun's Parallax. "	No. of Comparisons.
Washington and Melbourne	8·971	19
Washington and Sydney	8·885	7
Washington and Cape of Good Hope	8·896	7
Melbourne and Leyden	8·969	27
Melbourne and Cambridge, U.S. ...	9·138	10

With respect to the large value of parallax given by comparison of Melbourne and Cambridge, Prof. Eastman remarks: "This difference may arise from the method of observing over inclined threads at Cambridge, for the agreement of the results among themselves is very satisfactory; but, whatever the cause of the discrepancy may be, it has not been deemed advisable to employ these values in obtaining the final result."

The mean of the remaining sixty results, with regard to the computed weights, gives for the solar parallax, $8''\cdot953 \pm 0''\cdot019$.

It has been assumed that this method of determining the sun's parallax is certain to give too large a value, and Mr. David Gill, now H.M. Astronomer at the Cape, has suggested a definite cause; but Prof. Eastman, after experimenting upon Jupiter, does not find in his case that Mr. Gill's theory holds good. He intends, however, to pursue the investigation upon the disk of Mars.

VARIABLE STARS.—An ephemeris of the variable stars, similar to those of previous years, has been issued by the "Astronomische Gesellschaft" for 1882. It contains the times of maxima and minima of most of the variables whose periods are known, including, in addition to Algol, five stars of the Algol-type, viz. λ Tauri, S Cancri, δ Libræ, U Coronæ, and U Cephei. A minimum of Mira Ceti is fixed to February 3—this phase has been much less observed than the maximum. Both this minimum and the following maximum on May 23 are dated about ten days earlier than Argelander's formula of sines would indicate, but the observations of the last ten years have shown additional perturbation. A minimum of χ Cygni is dated February 20, and a maximum on August 25. The following are Greenwich times of minima of Algol :—

	h. m.		h. m.		h. m.
Feb. 1,	8 28	March 10,	15 4	April 2,	13 35
15,	16 33	13,	11 53	5,	10 24
18,	13 22	16,	8 42	22,	15 17
21,	10 10			25,	12 6
24,	6 59			28,	8 55

Minima of S Canceri occur February 16 at 11h. 23m., March 7 at 10h. 38m., March 26 at 9h. 54m., and April 14 at 9h. 9m.

For U Cephei (Ceraski's variable) calculated times of minima are :—

	h. m.		h. m.		h. m.
Feb. 1,	15 8	March 3,	13 3	April 2,	10 58
6,	14 47	8,	12 42	7,	10 38
11,	14 26	13,	12 22	12,	10 17
16,	14 6	18,	12 1	17,	9 56
21,	13 45	23,	11 40	22,	9 35
26,	13 24	28,	11 19	27,	9 15

A minimum of U Coronæ is dated February 6 at 10h. 7m.; the period is 3d. 10h. 51·24m.; the extent of variation about one magnitude.

THE ROYAL ASTRONOMICAL SOCIETY.—We are happy to be able, on the authority of Prof. Winnecke, to correct a mis-statement in this column, referring to the decease of M. Gautier as leaving Prof. Plantamour the senior Associate on the list of this Society. Notwithstanding some reports to the contrary, Prof. Winnecke informs us that this position is occupied by Prof. Rosenberger, who is still alive and in good health. Forty-five years have elapsed since the Society's gold medal was presented to Prof. Rosenberger, at the hands of Sir George Airy, for his masterly and elaborate researches on the motion of Halley's Comet. He was elected an Associate in April, 1835.

THE GREAT COMET OF 1881.—On January 7 and 8 Prof. Winnecke obtained good determinations of the position of this comet, which is still well observable with the great refractor at Strasburg. Its apparent diameter was about 30", and there was a condensation presenting the brightness of a star of $13\frac{1}{2}$ m. The resulting places are—

	M.T. at Strasburg. h. m. s.	R.A. h. m. s.	Decl. ° ′ ″
January 7 ...	7 49 6 ...	22 50 21·70 ...	+57 48 59·0
8 ...	7 33 3 ..	22 52 49·72 ...	+57 42 15·2

It will be seen that Dr. Dunér's ephemeris in the *Astronomische Nachrichten* still gives the comet's position pretty closely.

THE DETERMINATION OF ELECTROMOTIVE FORCE IN ABSOLUTE ELECTROSTATIC MEASURE

HAVING already described my absolute sine electrometer before the Physical Society and at this year's meeting of the British Association, there is no necessity for describing here more than the prominent features of the instrument. Two plates of brass, each about one foot square, their surfaces being rendered true planes, are connected together, as a rigid body, by four ivory axes passing through both plates near their corners. On these axes are placed (between the plates) washers of mica, which serve to keep the plates asunder and parallel at a very small distance from each other. One of the plates is continuous; the other (the guard plate) has in its centre a square aperture whose side is 3 centimetres long, and in this aperture hangs a very light disk of aluminium suspended from the top of the guard plate by two Wollaston platinum wires each about 7·5 inches long. The disk is flush with the guard plate when it rests against four fine screws attached to the latter. The system of plates is movable, as a rigid body, round a horizontal axis, and its motion is produced by a micrometer screw (1-16th of an inch pitch) working against an insulated portion of the lower edge of the continuous plate; thus the screw tilts the system out of the vertical to a measurable amount. The horizontal axis of the plates is carefully levelled with a cathetometer, and the exact distance between the plates is determined by three readings of a spherometer taken at the aperture of the guard plate (previous to the insertion of the disk) before the mica washers are inserted between the plates (the plates being in complete contact), and three readings at the same points after the insertion of the washers. The vertical distance between the centre of the axis of plates and the point of the micrometer screw is 15 inches; the weight of the disk ·2568 grammes; and the head of the micrometer screw is a circle 3 inches in diameter, divided into 1000 equal parts.

The essential principle of the instrument will be understood from the following figure. B is the horizontal axis about which the plates C (the continuous plate) and G (the guard plate) are tilted by the fixed micrometer screw A. The disk is represented by the full line D in the centre of the guard plate.

To measure the E.M.F. of a battery, put C in connection with the positive pole, while the negative pole and the guard plate (and, with it, the disk) are connected with earth.

If N is the attraction exerted on the disk by the charge on C, W = weight of disk, θ = angle of deflection of the plates from the zero, or vertical, position, we shall have, when the disk is *just* out of contact with the little screws which keep it flush with the guard plate,

$$N = W \sin \theta \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

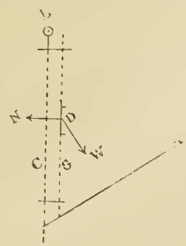
For the particular instrument which has been constructed for

me by Mr. Groves of Bolsover Street, the above equation becomes (using the circular measure for the sine)

$$V = \cdot 0456 \sqrt{m} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

in which V is the difference of potential between the poles of the battery, and m is the number of turns of the micrometer screw from the vertical position (in which $\theta = 0$) to the limiting position of equilibrium, or that in which the disk is *just sustained* out of contact with the screws.

The disk is observed from behind the guard plate by means of a microscope attached rigidly to the plate and moving, of course,



with it. The slightest motion of the disk can be thus seen; and when, by tilting the plates, the attraction N ceases to cause a motion of the disk, we know that the limiting inclination θ is attained.

As there would be great difficulty in determining the vertical position of the plates accurately, I do not seek to determine it, but use a differential method. Thus, suppose that we use n cells in each of which the E.M.F. is E, and let the reading of the micrometer be m when the limiting position is reached; now use n' of the cells, and let the reading for equilibrium be m'; then we know $m - m'$ but not m and m' separately. Substituting nE for V in equation (2), we have

$$n^2E^2 = (\cdot 0456)^2 m.$$

Also

$$n'^2E^2 = (\cdot 0456)^2 m'.$$

$$\therefore \quad E = \cdot 0456 \sqrt{\frac{\Delta}{n^2 - n'^2}}, \quad . \quad . \quad . \quad . \quad (3)$$

where Δ stands for $m - m'$.

Of course it is obvious that, to reduce any error of reading to a minimum, it is advisable to use for n and n' a large number and a small number, respectively. With the present instrument it is not possible to use more than about fifty Leclanché cells, because these produce such a large displacement of the disk that the amount of play allowed is exhausted.

A series of experiments carried out last summer in Prof. G. Carey Foster's laboratory gave for the E.M.F. of each cell of a battery of fifty Leclanchés ·00475 absolute electrostatic units.

This was obtained on the supposition that the E.M.F. was the same in all the cells, a supposition which is extremely improbable.

Within the last few days I have repeated the experiments on a different principle. My first idea was to work with a battery of Grove elements. Each element consisted of a test-tube containing a saturated solution of sulphate of zinc, and inside this a smaller test tube containing nitric acid, both test-tubes having the same axis, and both fitted into a paraffin cork, or stopper. A little zinc rod (surrounded with a very thin glass tube open at its lower end) plunged into the liquid of the outer test-tube and came up through the paraffin stopper; a platinum wire came up similarly out of the nitric acid; and electrical communication between the liquids was maintained by an aperture in the inner test-tube, through which the fumes of the nitric acid passed into the outer.

The resistance of the cells was, of course, enormous. They were formed into a battery, and supported in a wooden board soaked with paraffin.

The result then obtained for the E.M.F. of the Grove was much below what I knew to be about its value. The reason of this appeared to be that, with the great internal resistance of the battery, the external resistance was not sufficiently great. I therefore *diminished the internal*, and at the same time *increased the external*, resistance by inserting threads of asbestos through the apertures in the inner test-tubes, the extremities of every thread dipping into both liquids, and also by suspending each cell separately by a fine silk thread, about 2 feet long, from a fixed horizontal glass rod. The result was an increased, but still unsatisfactory, value of the E.M.F., and the unsatisfactory result was due to the fact that the nitric acid gradually attacked the zinc rods.

The employment of cells of exceedingly high resistance for the measurement of electromotive force is open to the serious objection that with them it is necessary to have a practically infinite external resistance, and this it is not always easy to attain. Even with the Thomson quadrant electrometer such cells give an uncertain result. When we have to trust for conduction to fumes or a moist film between two glass vessels containing the liquids, we occasionally get no indication whatever from the electrometer, and it is only by shaking up the cells that the requisite conductivity is obtained.

The above form of battery was abandoned for a series of chloride of zinc elements. Here the internal resistance is comparatively small, but we must not assume all the cells to have the same E.M.F. I therefore took forty of these elements, and compared their electromotive forces by a Thomson quadrant electrometer. In this way I found a variation of more than 8 per cent. in the E.M.F. of two cells.

Denote the electromotive forces of the cells by E_1, E_2, E_3, ... and let D stand for the electromotive force of a given Daniell, or any other element whose E.M.F. is to be found absolutely; and let the *ratios* of E_1, E_2, ... to D, as determined by a Thomson quadrant electrometer, be r_1, r_2, r_3. . . . .

Now suppose that we use any number of the cells with the absolute sine electrometer, and that the sum of their electromotive forces, $(r_1 + r_2 + r_3 + . \; . \; .)$D, is denoted by D.$\Sigma r$. Note the reading of the micrometer screw when the limiting deflection of the plates is reached. Then use a smaller number, whose total E.M.F. is represented by D.σr, and take the new reading. If Δ is the difference of readings, we have by equation (3)

$$D = \cdot 0456 \sqrt{\frac{\Delta}{(\Sigma r)^2 - (\sigma r)^2}} \quad . \quad . \quad . \quad . \quad (4)$$

The ratios r_1, r_2, . . . must, of course, be marked on pieces of paper attached to the outsides of the corresponding cells.

I quote the result of the measurement of the E.M.F. of a particular Daniell. Taking observations with 39 of the chloride of zinc cells and with 10 of them I found

$$\Delta = 14 \cdot 2;$$

also the registered values of the ratios r_1, r_2, . . . gave in this case

$$\Sigma r = 50 \cdot 427 D; \; \sigma r = 12 \cdot 834 D;$$

and by substituting in equation (4) we have

$$D = \cdot 00352 \quad . \quad . \quad . \quad . \quad . \quad . \quad (\alpha)$$

absolute electrostatic units as the E.M.F. of the Daniell.

Again, taking observations with 39 and 20 of the cells, I found

$$\Delta = 11 \cdot 17;$$
$$\Sigma r = 50 \cdot 427 D; \; \sigma r = 25 \cdot 918,$$

and these numbers substituted in (4) give *exactly* the value (α) above.

It is not possible, with the present instrument, to work with two batches of cells differing slightly in number; for I find that in some cases I cannot be certain of the reading corresponding to limiting equilibrium within about one-fifth of a revolution of the screw head. This uncertainty is of no consequence when Δ is large; but it is capable, I believe, of being almost completely got rid of.

Sir William Thomson's final estimate of the E.M.F. of a Daniell is

$$\cdot 00374$$

absolute electrostatic units ("Electrostatics and Magnetism," p. 246).

The Daniell cell used in the above experiments was a particular form of "gravity" arrangement, and I have good reason to believe that its E.M.F. was somewhat below that of a normal Daniell. Hence the value obtained for its E.M.F. may be quite consistent with Sir William Thomson's number.

I hope before long to determine by means of the absolute sine electrometer the E.M.F. of a cell which is also known in electro-

magnetic measure, on account of the supreme importance of such a measurement in the theory of light.

I may in conclusion refer to a possible objection. The force of "stiction" may be supposed to interfere with the reading of the limiting position of equilibrium. Practically the objection is groundless, for we can always (force of stiction notwithstanding) attain this position very nearly. Having done so, a very slight tap on the base of the instrument is sufficient to free the disk and take it slightly out of focus, where it remains. Then move the plates forward by means of the micrometer screw until the guard plate again catches up the disk. We thus get the position of equilibrium without the interference of stiction at all.

I am now having the instrument altered by Mr. Groves. A very light and flat gilt disk of mica suspended by silvered silk fibres will replace the aluminium disk, and the distance between the plates will be varied within very narrow limits, so as to show whether the cushion of air between the plates exercises any influence on the results.

The range of tilting of the plates will also be increased so as to allow of the employment of a large number of cells. In this case the equations previously used must be replaced by equations of the forms—

$$\operatorname{Sin}(\theta+a)=k\mathrm{E}^2,$$
$$\operatorname{Sin} a=k'\mathrm{E}^2,$$
$$\tan(\theta+a)-\tan a=c,$$

where k, k', and c are known constants. In these equations we can, of course, take a very small, as before, and get a very approximate and easily obtained solution by using expansions to the third order of small quantities—as I shall show in a subsequent communication on the completion of my experiments.

GEORGE M. MINCHIN

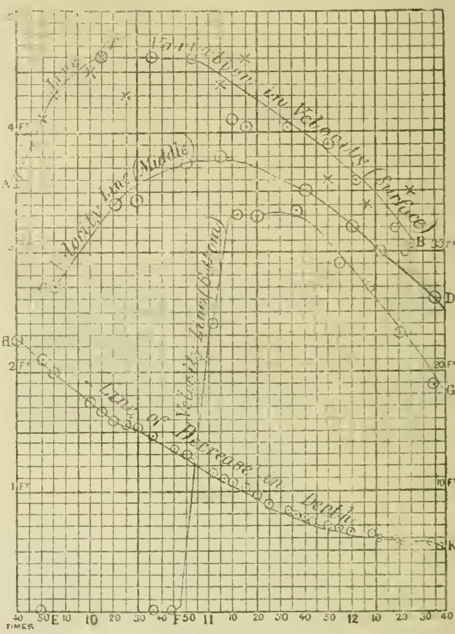
Royal Indian Engineering College, Cooper's Hill, December 1

VELOCITIES IN TIDAL RIVERS

A PAPER "On the Relative Value of Tidal and Upland Waters in maintaining Rivers, &c.," by Mr. Walter R. Browne, M.Inst.C.E., late Fellow of Trinity College, Cambridge, has been lately published by the Institution of Civil Engineers. The main object of it is to prove, as a general principle, though by no means applicable in every case, that the main agent which keeps clear the channels of tidal rivers is not the run of tide passing up and down them every twelve hours, but the upland or fresh waters which pass down them at the period of low water, more or less aided by the oozing out of salt water which has soaked into the banks while covered with the tide.

The author, with a view to check his conclusions by actual experiment, resolved to investigate the actual velocity at the bottom of a tidal channel during an ebb tide; since it is clear that, whatever the velocity at the top, it is the bottom velocity alone which produces any scouring effect. In the very largest rivers, above the action of the tide, the bottom velocity differs but little from the surface velocity; but in smaller streams it is generally much less than the surface velocity, and the ratio between the two decreases rapidly as the depth increases. The case of a tidal river however is somewhat different, because then the level of the bottom is below the surface of the ocean outside, and this must have a certain effect in ponding back the river current. Accordingly two sets of experiments, made at a carefully-chosen spot on the River Avon at Bristol, showed that for about two-thirds of an ebb tide, and even when the surface velocity was at its highest, the bottom velocity was absolutely *nil*. The water at the bottom then seemed to start suddenly into activity, and almost immediately assumed a velocity agreeing fairly with that observed in ordinary rivers above the tidal area. The two sets of experiments were made with different meters, at different states of the tides, and at different times of year; so that they amply confirmed each other. The stillness of the bottom was further proved by the board, supporting the rod on which the meter was hung, coming up with a deposit of silt upon its surface, showing that, far from any scouring being in progress, actual deposition was taking place. The second set of experiments was the most accurate, the meter having been specially made and tested for the purpose. The results are plotted on the accompanying diagram.

In the diagram the line A B represents the probable variation in the surface velocities as sketched from the various observations. The small circles represent the observations made at different times by the meter, and the crosses represent observations made, as a check upon these, by floats at the surface. It will be seen that the meter observations are by far the most satisfactory. The line C D is similarly sketched from the observations of the velocities at the middle of the depth. It will be observed that here the maximum velocity is attained later than at the surface, and just when the latter is beginning to fall off. The line E F G and the circles contiguous to it refer to the bottom velocity. It will be seen that it rises from nothing to a tolerably high value, with very great abruptness, just at the time when the surface velocity begins to diminish: it is probable, however, that



the change is not so much connected with this as with the decrease in depth, which is given by the line H K and the contiguous circles. These are plotted to one-tenth the scale of the velocity observations, and the sudden flattening of the curves about 12 noon marks the beginning of what the author terms the low water period.

It is believed that the fact of a current having a high velocity at the surface and absolutely none at the bottom has not been previously observed, and it may have considerable bearing on the general theory of the motion of rivers, as well as on the more practical points dealt with in the paper.

ON THE ECONOMICAL USE OF GAS-ENGINES FOR THE PRODUCTION OF ELECTRICITY[1]

THE lecturer pointed out, that as long as the chief practical use of electricity was in telegraphy it was the quickness of action, rather than the ability to transmit large amounts of power to a distance, that formed the chief feature in the employment of electricity; but that in this exhibition the numerous practical examples of the electric transmission of power, rather than the electric transmission of signals, formed without doubt the leading feature.

Much had been heard about the dynamo-electric machines which generate the electric current; but while electricians were

[1] Abstract of a lecture delivered in French in the Salle du Congrès, at the Electrical Exhibition, Paris, by Prof. W. E. Ayrton, F.R.S.

engaged in considering the differences between the various kinds of these machines and the improvements that can be effected in them, the mechanical engineer should give his careful attention to the possible improvements that can be made in the engines that drive the electric generators.

As long as the lighting of our large cities was performed by gas the cheap manufacture of illuminating gas was the important question, but now that electric lighting bids fair to displace other systems the question that has special interest is, not the extraction of illuminating gas from coal, but the employment of the store of energy in the latter to set in rapid rotation dynamo-electric machines for producing the electric current used in lighting.

At present steam-engines are chiefly used to drive the dynamo machines, but even with the best engines and boilers it is well known that the fuel consumption is excessive compared with the actual work done. So good an authority as Sir William Armstrong has recently said that with a good condensing engine only one-tenth of the whole heat energy of the fuel is realised in useful work, and this is no exaggeration of facts. What therefore must be said of a small engine and boiler of the ordinary type? The main reason why the efficiency of even the best steam-engines is so low is because in an ordinary engine steam can only be used at a comparatively low temperature; for it can be proved that, with the temperatures which can be used in condensing-engines, the efficiency of even an imaginary perfect engine, without friction and loss of heat, cannot exceed $\frac{2}{10}$, or only double the efficiency of a good modern steam-engine; that is to say that a good engine of large size uses only $\frac{1}{10}$ of the total heat, and that it is not possible to use more than $\frac{2}{10}$ with an engine of perfect mechanism.

It may be assumed that in large compound marine engines the fuel consumption is about 2 lbs. per indicated horse-power, but it cannot yet be said that engines of this class and of very high power will be used in central stations for electrical purposes; at any rate it must be remembered that besides other considerations there is a great objection to the use of a single very large engine to electrically light a district, for the accidental stoppage of this engine would plunge the whole neighbourhood into darkness.

Engines and boilers of the portable type are those generally used now for electrical purposes, and in a competition in England of several of the best engines of this class the fuel consumption was about 4 lb. per indicated horse-power per hour; but in daily practical work it may be assumed that 6 to 7 lb. more nearly represent their usual fuel consumption. This gives an efficiency of only about $\frac{1}{30}$.

With a hot-air engine there is this great disadvantage, that it is extremely difficult to prevent the lubricants from being burnt and the air vessel being injured by heat, since the latter vessel must be kept as hot or hotter than the air, because the temperature of the air is raised by an *external* fire. The only other motor suitable for electrical purposes (apart from machines driven by water or wind power) is the gas-engine. In the latter the power is obtained by the admission of an explosive mixture of gas and air into the cylinder, and the piston is driven by the explosion produced on the ignition of this mixture.

Now there is this great difference between a hot-air engine and a gas-engine, that in the latter the high temperature arising from the explosion is produced *inside* the cylinder, and not outside: so that, although the gas at the moment after explosion is extremely hot, the cylinder, piston, and lubricant may be kept cool by an external stream of water, which is of course impossible in a hot-air engine where the air is heated from the outside. Again, the very high temperature developed in the cylinder after the explosion has taken place is rapidly reduced by the piston doing work before there is time for the gas to give up much of its heat to the cylinder and piston. Steam, however, can only be used at a very high temperature, provided the apparatus is made exceedingly strong.

With the present temperatures employed, the theoretical efficiency of a gas-engine might be raised from 56 to 75 per cent., if loss of heat by conduction, radiation, and convection, as well as friction, could be prevented; while in a condensing steam-engine the greatest efficiency that could be obtained with the present temperatures employed could never exceed about 20 per cent.

It was thus shown that practically a gas-engine admits of being worked with much greater *efficiency* than either a steam-engine or a hot-air engine—that is to say, the percentage of heat the former turns into mechanical work is much greater than with the latter two. It was, however, necessary to consider the *economy* of working, which depends on the relative price of the fuel employed, and other items of working cost. Comparative estimates were therefore given of the working cost of a steam-engine of the portable type and of an Otto gas-engine, both indicating 30 horse-power, for 300 days of nine hours each (the horse-power about necessary to keep alight the 400 Swan incandescent lamps used to illuminate the Salle du Congrès during this lecture). The cost of the coal-gas was taken at three shillings per 1000 cubic feet (or about $13\frac{1}{2}$ centimes per cubic metre, only about half the actual price in Paris), and it was thus seen that, in spite of the very great relative efficiency of the gas-engine, the cost of working with ordinary coal-gas is greater than in the case of the steam-engine. Ordinary coal-gas, however, has been prepared for producing not heat, but light, and has therefore been elaborately purified at a considerable cost, so that when used in a gas-engine it is used for a purpose quite different from that for which it was intended.

A gas-engine burning illuminating gas is, in fact, in the same position as was a few years ago an electromotor, or machine for converting electric energy into mechanical power. An electromotor is an extremely efficient machine, but the fuel burnt to produce the electricity was, until quite recently, zinc, and consequently was far too expensive to allow the use of electromotors to be commercially successful. So in the same way, if it is attempted to work gas-engines by burning illuminating gas at even $13\frac{1}{2}$ centimes the cubic metre, or half the actual price of the ordinary gas in Paris, they cannot even be worked as economically as steam-engines, in spite of their superior efficiency and of the much smaller cost for superintendence. But if it be possible to manufacture for their use a cheap heating gas in the same way as it is now possible to produce electric energy economically by burning coal, which is a much cheaper fuel than zinc, then the result, as you will see, becomes just the reverse, and small gas-engines driven with such gas not only greatly surpass in economy steam-engines of the same size, but produce energy at a cheaper rate per horse-power than the largest steam-engines ever made.

The lecturer then described what had been done by Dr. Siemens and others who have made a heating gas for furnace work by means of passing air only, or air with a small admixture of steam, through a mass of burning fuel. Such gas, however, contains too much nitrogen (60 to 70 per cent.) to be suitable for gas-engines and other purposes requiring it to be used in small quantities, and the plant is large and costly. Reference was then made to what had been done by Mr. Dowson of London, who has perfected a gas-generating apparatus, into which he passes steam at pressure with a certain portion of air. This he effects by an arrangement similar to a steam-engine injector or a jet pump. The air thus drawn into the generator serves to keep the column of fuel through which it passes at a high temperature, without an exterior fire, so that the decomposition of the steam and the other chemical reactions take place without interruption. The working of the generator is thus regular, and the gas is produced without fluctuations in quality.

Experiments were made with a eudiometer, in which were three volumes of the Dowson gas and one of oxygen, and on exploding the mixture, 36 per cent. of the total disappeared. This corresponded with the following composition of the Dowson gas, viz. hydrogen, 20 per cent.; carbon monoxide, 30 per cent.; carbon dioxide, 3 per cent.; and nitrogen, 47 per cent. by volume. It was also shown that this gas burns without smoke or any deposit of soot on a piece of porcelain, whether placed above or in the middle of the flame.

About 50 per cent. of this gas is combustible, and its calorific power, or the number of heat units produced by the combustion of a cubic metre, is 1,558,358. Its calorific intensity is 2268° C. To compare it with ordinary coal-gas we may take the calorific power of a cubic metre of the latter to be 5,590,399, and its calorific intensity as 2554° C.

In the Otto gas-engines a large proportion of air is mixed with the coal-gas, so that the effect of the explosion may continue during the stroke of the piston by the air taking up some of the heat produced; and as the Dowson gas requires less air for its combustion, it is found that in the same cylinder there is not more nitrogen and unused oxygen in the charge of Dowson gas with its mixture of air, than with coal-gas and the quantity of air which is given to the latter. That is to say that the same power can be developed in the engine with coal-gas or Dowson gas if the supply of gas and air be exactly proportioned.

The comparative explosive force of the two gases calculated in the usual way is as 3·4 : 1, *i.e.* coal-gas has 3·4 times more energy than the Dowson gas. But because the combustion of carbon monoxide proceeds more slowly than that of carburetted hydrogen gases, and because the diluents present in the cylinder affect the weaker gas more than the coal-gas, in practice, with an Otto engine five volumes of the Dowson gas are used for one volume of coal-gas.

A table was given showing all the working expenses of an Otto gas-engine indicating 30 horse-power, and driven by the Dowson gas for 300 days of nine hours each, so that these expenses might be compared with those given for the steam-engine and the gas-engine worked with coal-gas. These figures showed that a gas-engine worked with Dowson gas costs about 45½ per cent. less than when worked with coal-gas at 3*s.* per 1000 cubic feet, and about 47½ per cent. less than a steam-engine of the portable type, after allowing in each case for repairs and depreciations, and interest on capital outlay. The most striking feature, however, was that with a steam-engine consuming 6 lbs. of coal per indicated horse-power per hour, and without adding any allowance for fuel used in getting up steam, and after work is done, 217 tons of coal are required to give the same power as 39 tons of coal converted into gas by the Dowson process. This represents a saving of about 88 per cent. in the weight of fuel.

Another practical consideration was that the quantity of the Dowson gas required to give the equivalent of 1000 cubic feet of coal-gas was only 24 to 27 per cent. of the weight of the coal necessary for the latter. A further point of great interest is that a series of trials made with 3½ horse-power (nominal) Otto engines driven by the Dowson gas, have proved that 1 *horse-power* (*indicated*) *is obtained with a consumption of gas derived from* 1·46 *lbs. of coal* after allowing for the gas burnt in the manufacture of the gas as well as 10 per cent. for impurities and waste of the coal. With gas-engines of larger power the loss due to friction is proportionally less, and the consumption of gas per indicated horse-power is less, thus with a 16 horse-power (nominal) engine which can indicate up to about 40 horse-power, the Dowson gas required would be about 90 cubic feet per indicated horse-power per hour, and this would give a consumption of coal of *only* 1·2 *per indicated horse-power per hour.*

Moreover, with a cheap heating gas not only can a saving in the motive power be effected for electric lighting, but this gas can also be used for domestic and industrial purposes, such as cooking and heating. It burns without smoke, so that when it is used in districts where there are many factories, or where much coal is consumed, not only will a great saving be effected, but in addition there will be freedom from a dark depressing atmosphere—the presence of which, the lecturer remarked, was the bane of London, and the absence of which formed the greatest charm of Paris.

NEW BIRDS FROM THE SOLOMON ISLANDS

AT a recent meeting of the Linnean Society of New South Wales Mr. E. P. Ramsay, F.L.S., &c., Curator of the Australian Museum, read descriptions of the following six new birds from the Solomon Islands:—

Astur versicolor.—The whole plumage above and below is of a bluish slate-black, the base of the quills below ashy white. The length is about 17 inches, the wing 9·7. The immature nd young birds are also described.

The adult male of *Nasiterna finschii* is described as having a crimson patch on the abdomen; otherwise like the female, which alone was previously known. The young of this species is also described; they differ in having a rosy tint on the cheeks.

A fine pigeon is described, and called *Ianthænas philippanæ*; it is allied to *I. pallidiceps*, but is not so dark in the plumage, being of a bluish slate colour, except the head and throat, which are white, with an opaline rose tint; the metallic reflections of the body are rose and light green; length 15 inches, wing 9¼ inches. Two other pigeons of the genus Ptilopus have been dedicated to officers of Her Majesty's Navy.

Ptilopus richardsii.—A very beautiful and distinct species, having the head, neck, and all the under surface French gray, a very faint lavender crown, the wings and tail green; the former have a rosy carmine oblong or lanceolate spot on the scapulars; the latter has a terminal band of pale yellow. The nest, eggs, and young of this species are also described.

Ptilopus lewisii.—This bird was previously described in the same journal, and referred to *Ptilopus viridis*, and afterwards determined as the female of *Ptilopus eugeniæ* (Gould). A large series of both sexes and the young show it to be a new species. The general colour is green, the chest with a large patch of violet-purple. A description will be found in the *Proceedings* of the Linnean Society of New South Wales, vol. iv. 1879, p. 73.

Ptilopus johannis of Sclater is stated to be the male of *P. solomonensis* of Gray, and to = *P. ceraseipectus* of Tristram.

A fine new Chalcophaps has been named after its discoverer, Mr. Alex. Morton, *Chalcophaps mortoni*; it is like *C. chrysochlora*, but larger, and has no band on the shoulder; the young had been previously described under the name of *C. chrysochlora*, var. *sandwichensis*; the name is now altered to that of *mortoni*, and the adult described.

Myiagra cervinicauda, Tristram.—The male of this species is described, the type-specimen being a female; it belongs to the *M. plumbea* group of the genus.

Sternoides minor.—A smaller species than either of the previously known species, and differs in having a more curved bill, and all the secondaries, as well as the primaries, of an earthy-brown tint. Length about 7½ inches, wing 4·3, tarsus 1 inch.

A second paper by the same author contains a description of a new honey-eater of the genus *Plectorhyncha*, or of a new genus very closely allied to it. This species, which is of a uniform dull fulvous brown, has been named *P. fulviventris.* It comes from the south-east coast of New Guinea. Length about 8 inches, wing 3·8, tail 3·2, tarsus 1 inch.

Mr. Ramsay stated that the trustees of the Australian Museum had recently received large collections from their collector in the Solomon Islands, and were daily expecting further consignments from New Guinea.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 12, 1881.—On the interference of phenomena of thin plates with special reference to the theory of Newton's rings, by W. Feussner.—On the dispersion of aragonite in an arbitrary direction, by V. v. Lang.—Remarks on Herr Lamansky's works on fluorescence, by O. Lubarsch.—Upper limits for the kinetic energy of moved electricity, by H. R. Hertz.—On disaggregation of electrodes by positive electricity and explanation of the Lichtenberg figures, by E. Reitlinger and Fr. Wächter.—Researches on the height of the atmosphere and the constitution of gaseous bodies (continued), by A. Ritter.—Contributions to the theory of electromagnetism, by W. Siemens.—Researches on the volume constitution of liquid compounds, by H. Schröder.—On the theoretical determination of vapour pressure and the volumes of vapour and liquid, II., by R. Clausius.—On an equation which satisfies the kinetic energy of vibratory movements, by S. Oppenheim.

Journal de Physique, December, 1881.—Hydroelectric and hydromagnetic phenomena, by C. A. Bjerknes.—Variation of indices or refraction of gypsum with temperature, by H. Dufet.—On the measurement of temperatures by means of the mercury thermometer, by M. Pernet.—On the singular polarisation of electrodes, by A. Solokoff.—Discourse of M. Dumas at the International Congress of Electricians.

Rivista Scientifico-Industriale, December 15, 1881.—Displacements and deformations of the spark in air by electrostatic action, by R. Righi.—On some curious conformation of the spark in air, by the same.—Endogenous origin of the roots of plants, by S. Briosi.

THE last two parts of the *Memoirs* (*Trudy*) of the St. Petersburg Society of Naturalists contain, besides the minutes of proceedings, the following interesting papers (vol. xi. fascicule 2):—A preliminary report on the structure of corals, and on the origin and development of the egg of the *Medusa leucope* before fructification, by K. S. Mereshkovsky.—Materials for the flora of the Onega region, by A. K. Hünter; and of the neighbourhood of Povenets, in the government of Olonetz, by Chr. Gobi.—(Vol. xii. fascicule 1):—A geological description of the neighbourhoods of Krasnoye and Tsarskoye Selo, by R. Kudryavtseff and J. Lebedeff (with map and plates).—On the aërial roots of the *Acanthoriza aculeata*, by K. Friedrich (with plates).—On the influence of light on mushrooms, by K. Regel.—On the Imatra waterfall and Imatra stones, by P. Venukoff.—Report on the expedition to the White Sea, by L. Tsenkovsky. This volume

is dedicated to the memory of the late Prof. Kessler.—Zoologists will find valuable contributions to the knowledge of Russian zoo-geography in the researches of MM. Khlebnikoff, Nikolsky, and Lavroff as to the fauna of the governments of Novgorod, Astrakhan, and Kaluga, published in vol. xi. of these *Memoirs*.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 15, 1881.—"On some Effects of Transmitting Electrical Currents through Magnetised Electrolytes." By Dr. G. Gore, F.R.S.

This communication treats of a class of electro-magnetic rotations observed and examined by the author. The rotations are produced in liquids by means of axial electric currents either in the interior of vertical magnets, electric or permanent, or near the poles of such magnets; and differ from rotations previously produced in liquids placed in those positions, by the absence of radial currents, to the influence of which rotations in the interior of hollow magnets have hitherto been ascribed. In the full paper it is stated that "the whole of the results may be explained by the well-known principles of electro-magnetism."

It is here shown that a column of an electrolyte placed under similar conditions to an iron wire or rod when subjected to electro-magnetic torsion (*i.e.* inclosed by an electro-magnetic helix, and traversed axially by an electric current), is twisted in a similar manner to the wire or bar. This effect, however, in the case of a liquid, is not limited to paramagnetic substances, nor is the direction of torsion altered by the magnetic character ot the solution.

The rotations produced in liquids by means of axial currents are opposite in direction at the two ends of the magnet-tube, are strongest at the poles and at a little distance beyond them, and null at the centre of the tube:—they may be produced at a distance of several inches beyond the poles. The directions of rotation within the tube, and to a short distance beyond the poles, are, in the case of an electro or a permanent magnet, opposite to those produced by a voltaic solenoid; a magnet-tube, therefore, has three points of no rotation with an axial current, viz. one at its centre and one near each end, whilst a solenoid has only the former one. The existence of the outer neutral points produced by a magnet depends upon the position of the latter to the liquid, and the distances of those points from the poles of the magnet are affected by various circumstances which are described in the communication. If the magnet is wholly above the portion of the liquid traversed by the axial current, the outer neutral points do not occur.

By the influence of a vertical current, the liquid as a whole may be made to rotate in either single direction; the motion at one end of the column, therefore, is not dependent upon the opposite direction of motion at the other, and torsion is not a necessary form of the effect. The reaction of the liquid in the production of the rotation is neither upon another portion of the liquid, nor upon the electrodes, nor upon the walls of the containing vessel, but upon the adjacent magnetised body; the rotation of the liquid is confined to the portion traversed by the vertical current.

Under suitable conditions the phenomenon of rotation is definite, conspicuous, and strong, and is usually more powerful with a tubular electro-magnet than with a voltaic coil alone; a very thin iron tube weakens the effect of the coil, whilst a thick one reverses the motion and makes it stronger. The system of rotations, either with a coil or magnet, is also perfectly symmetrical. The directions of rotation produced by a coil alone are independent of the magnetic nature of the wire of the coil. Like other electro-magnetic effects, the rotations are not prevented by the interposition of metallic screens, provided they are non-magnetic. The rotations may be easily produced by the aid of a current from three or four Grove's elements, especially if permanent bar-magnets are used instead of a voltaic coil. The rotations by means of vertical currents in the liquid may be produced by the influence of coils or magnets, either above or below the liquid, as well as around it; with magnets, however, in the former positions, no external reversal points occur. A magnet placed entirely above or below the liquid produces the same directions of rotation as a coil placed either above, below, or around it. The direction of rotation produced in a liquid above a coil by an *upward* current in the liquid agrees with that produced by a *radial centripetal* one.

A rotation apparatus of the same kind, interposed as a screen, does not prevent or appear to affect the movements.

Each electrode may be made to separately revolve in the presence of a coil or magnet, by the well-known influence of the radial currents in them; and the directions of rotation are the same with a magnet as with a coil. In this respect the motion produced by radial currents differs from that produced by vertical ones. With each electrode, diverging currents produce dextro- and converging ones lævo-rotation. The rotation of the electrodes by means of radial currents appears to be independent of that produced in the liquid by means of vertical ones.

The rotation also of the vessel containing the liquid may be obtained independently of that of the electrodes, by means of the vertical current in the liquid, without the aid of the radial currents in the electrodes.

The rotations produced by a vertical axial current are not confined to liquids, but may also be produced in a solid conductor, and probably therefore with any body conveying an electric current or discharge.

The directions of rotation produced in liquids by means of radial currents under the influence of a magnet or coil, are the same as in the solid electrodes, and are lævo at all positions with centripetal currents and dextro with centrifugal ones, when the North Pole is above.

A given direction of axial current, whether in a solid or liquid conductor, whether above or below a given magnetic pole, and whether that pole constituted the upper or lower end of a coil or magnet, produced the same direction of rotation. A given direction of radial current also, whether in the electrodes or electrolytes, or above or below a given pole, provided that the pole was not altered in position, produced the same direction of rotation.

Various other phenomena, such as temporary reversals of the direction of rotation, successive action of the coil and iron tube, &c., &c., are recorded in the paper.

With a Solenoid.—A current flowing upwards from a south to a north-seeking pole produces dextro rotation at the former, and lævo rotation at the latter. *With a magnet* these two directions are reversed at all distances between the two neutral points near the poles of the magnets, but not beyond. The phenomena therefore of rotation are more complex with a magnet than with a solenoid.

The reversals of direction of rotation which occur when a tubular magnet is employed appear to be due to the inner surface of the magnet and to the position of that surface in relation to the current in the liquid. The direction of rotation and the points of reversal appear to be all independent of each other.

The action of radial currents is more simple than that of axial ones, especially near the poles of a magnet. With radial currents, either in the liquid or electrodes, there is no reversal either at the centre of the magnet or coil, or at the poles or beyond them.

The experiments show in a conspicuous manner the difference of property of the interior surface of a hollow magnet and of that of a solenoid having the same kind of poles at their corresponding ends. This difference of property is well known, but is illustrated in the paper in a new way experimentally.

The whole of the foregoing results are illustrated by experiments.

Mathematical Society, January 12.—S. Roberts, F.R.S., president, in the chair.—Dr. G. J. Allman and Mrs. Bryant were elected Members, and Mr. G. H. Stuart was admitted into the Society.—A vote of thanks was passed to the Norwegian Government for the present of a copy of the new edition of Abel's works.—The following communications were made:—The invariants of a certain orthogonal transformation, with special reference to their use in the theory of the strains and stresses of an elastic solid, by Mr. W. J. C. Sharp.—Some formulæ in elliptic functions, by the Rev. M. M. U. Wilkinson.—Complete determination of the real foci, and of the vector equation, of a given ellipse with respect to any proposed point, by Prof. Wolstenholme.—On the calculation of symmetric functions, by Mr. J. Hammond.

Royal Horticultural Society, January 10.—*Hylecœtus dermestoides:* Mr. Pascoe showed a male and a female specimen of this British beetle, and alluded to the report that it feeds on the wood-boring species, but does not itself bore the wood. Mr. Maclachlan remarked that it was an open question whether this idea were true.—*Glastonbury Thorn:* Dr. Masters exhibited specimens of this plant received from Mr. Boscawen,

with buds and fruit. It was flowering later than usual. He also showed a variegated sport of the common laurel from the same gentleman.—*Willow, species of:* Some specimens of new species of willow, *e.g. S. holosericea*, &c., were received from Dr. Fraser, of Wolverhampton. It was suggested that they were hybrids or accidental importations. They were forwarded to the Kew Herbarium.—*Carica condamarcensis, Fruit of:* A fruit of this plant was received from Mr. J. A. Henry, of Edinburgh. It was raised from seed sent by the late Prof. Jameson of Quito, and had been fertilised by the late Prof. Dickson.—*Nitrogen in worm-casts:* Dr Gilbert described some experiments he had made in order to ascertain the proportion of nitrogen in worm-casts; which latter, according to Mr. Darwin, amount to between 17 and 18 tons per annum per acre, of ·2 inch in depth. He collected the casts of two or three weeks' formation, and found, by analysis of the *dried* mould, that it contained ·35 per cent. of nitrogen, which is higher than that of mould of pasture land, viz. ·25–·3 per cent. in the first nine inches, or two or three times as high as that of arable land, but not so rich as highly manured kitchen garden mould. Ten tons per acre would, therefore, yield 80 lbs. of nitrogen per annum, or more than double that of ordinary meadows without manure. The conclusion was that no gain accrued to the soil except from what the worms brought up from below, as by trenching.—*Plants exhibited: Columnæa Kalbreyerana*, with satin-like pendulous secund leaves and yellow flowers, from New Grenada, exhibited by Messrs. Veitch. It received a botanical certificate. *Tecophilæa cyanocrocus*, from Chili. This had flowered previously at Kew. It was brought by Mr. G. F. Wilson. A small bulbous plant with slender tubed and globular perianth of lilac colour, brought by Mr. Maw from Mount Ida, was exhibited by the Rev. H. H. Crewe. It was referred to Kew for identification and name [*Colchicum montanum*, Bieb.]. *Lygodictyon Forsteri*, a fine specimen of a climbing fern, from Mr. Green, of Kingsford Stanway, near Colchester. *Dracæna Goldiana*, exhibited by Mr. Wills, flowering for the first time in this country, with variegated foliage, received a botanical certificate.

Victoria Institute, January 16.—A paper on "Biblical proper Names, personal and local, illustrated from Sources external to Scripture," was read by the Rev. H. G. Tomkins. Communications from Prof. Sayce, MM. Renouf, Lenormant, Naville, &c., followed, and a discussion ensued, in which Dr. Rassam and others took part.

Paris

Academy of Sciences, January 9.—M. Jamin in the chair.—The following papers were read:—Documents relative to the subject of Papin's stay at Venice, by M. Daubrée. Papin went to Venice with Paul Sarotti, a Venetian senator whom he met in London, and who had founded an academy in his own house in Venice (beginning about 1632), with a valuable library. M. Daubrée, in a recent visit to Venice, gained some information about the work done at the meetings. The Sarotti Academy still existed in 1690.—On the powers and roots of linear substitutions, by Prof. Sylvester.—Experimental study on metalloscopy, hypnotism, and the action of various physical agents in hysteria, by MM. Dumontpallier and Magnin. Among other things, the authors suppose there is an intercrossing of sensitive and motor fibres in the dorso-lumbar region of the spinal cord, occasioning simultaneous movements of the upper limb on one side, and the lower on the other; excitation of the surfaces of the latter causes movement of the former. This may explain the walk of quadrupeds, of man "on all-fours," &c. The nervous hyperexcitability of hysteric persons in a state of hypnotism is illustrated. The so-called radiating neuric force in hysterics is merely a manifestation of physical acts called into existence (peripheric modifications caused by physical agents).—On the processes of coppering cast-iron, employed at the Val d'Osne, by MM. Mignon and Rouart. They use a distinctly acid solution, whereas *alkalinity* is the basis of M. Weil's method (in which the organic acid is only an accessory).—The Secretary gave the gist of a volume of memoirs by Prof. J. P. Cook of Harvard.—M. Dumas presented a fine work by M. Civiale, "Voyages photographiques dans les Alpes."—On an extension of the arithmetical notion of genus, by M. Poincaré.—On algebraic forms with several series of variables, by M. le Paige.—Differential equations of motion of waves produced at the surface of a liquid by the emersion of a solid, by M. Boussinesq.—On some consequences of the principle of Gauss in electrostatics, by M. Croullebois.—On a sound-transmitter with stringed sounding-board, by M. Bourhouze. A microphone is placed on the sounding-board of a piano or like instrument, and is affected by the strings vibrating in unison with sounds produced (with the voice or an instrument) near them. Such a transmitter is very sensitive.—Measurement of the interior resistance and the electromotive force of electric machines in action, by M. Cabanellas.—Note on the theory of formiates by M. Maumené. Thermal researches on oxychlorides of sulphur, by M. Ogier.—On a carbonic ether of hoemeol, by M. Haller.—On the formation of bases of the quinoleic series in the distillation of cinchonine with potash, by M. Œchsner de Coninck.—On terpine, by M. Walitzky.—On the existence of an automatic rhythm common to several nerve-centres of the medulla oblongata, by M. Fredericq. With inspiration (respiratory centre) there is diminution of arterial pressure and acceleration of pulsations (*i.e.* minimum of action of centres for vasomotors and for stoppage of the heart). With expiration and respiratory pause, the effects are opposite. This intermittent activity occurs apart from all change in the state of the thoracic organs, provided the blood bathing the medulla oblongata has a certain degree of viscosity; if it be too much arterialised, the three centres more or less suspend their action.—On the positions of equal luminous intensity in twin crystals, between crossed Nicols, and application to the study of the concentric bands of felspar, by M. Lévy. The felspars in rocks are generally formed by juxtaposition of *concentric bands*; and in these the optical properties vary irregularly, though the crystallographic orientation seems the same. Some have tried to explain this by supposing a variation in the chemical composition of the bands. M. Lévy pronounces this insufficient, and regards the bands as often due to a submicroscopic association of hemitropic lamellæ of a fundamentally single felspar, according to the laws of albite and of pericline.—On the artificial reproduction of analcime, by M. de Schulten. His former method was heating a solution of caustic soda in sealed tubes of ordinary French glass. In another, he mixes solutions of silicate and aluminate of soda, such that the silica and alumina are in the same ratio as analcime, adds some lime-water (to facilitate crystallisation), and heats in a copper tube at 180° for eighteen hours. While analcime, in natural specimens, has optical properties indicating the quadratic form, the author's first artificial reproduction gave crystals apparently rhombohedral, and his second, distinctly cubical crystals.—Study of subterranean waters in the department of the Meuse, by M. Holtz. Some parts of France, such as Normandy, are almost entirely without subterranean waters, owing to the refractory nature of their ground, but it is otherwise with the departments of the north-east (Meuse included), in the oolithic zone.—M. Pernolet indicated several examples of the diffusion of carbon.

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THURSDAY, JANUARY 26, 1882

THE RECENT WEATHER

THE weather of the winter months of 1881–82 bids fair to leave its mark on the annals of meteorology in an unmistakable manner. The abnormalities which are distinguishing it may be considered as having begun with the great storm of October 14, which was so disastrous to life and property, particularly among our seafaring population. During the last week of that month temperature fell low enough to produce frost on the ground, a circumstance here referred to from the significance attached to it by Sir Robert Christison, who has been so long one of our best and shrewdest observers of weather. Sir Robert's opinion is that when the temperature in Scotland during either the last week of October or the first week of November falls low enough to freeze the ground, an open winter will most probably follow, an opinion which the prevailing weather since has fully borne out.

The November which followed was, as we have already shown (NATURE, vol. xxv. p. 131), the warmest November in North Britain for the past 118 years, or since thermometers began to be employed to record the temperature. On the 27th of the same month the barometer, reduced to 32° and sea-level, fell at the Butt of Lewis to 27·865 inches, remaining at this low point from 4.30 to 7 a.m., this reading being probably the lowest barometer ever recorded in the British Islands; and over a wide area in the north-west and north of Scotland, and for a considerable time pressure was less than 28·000 inches. December was, generally speaking, as regards its meteorology, an average month, temperature being about a degree and a half above the mean in the north of the Shetlands, and as much below it in the south-west of Ireland; but over the greater portion of these islands the deviation from the normal temperature did not, either way, amount to a degree. Some frost occurred about the middle of the month, but so slight as scarcely to offer any serious check to the growth of grass, and many late and early flowering plants, which at this early season present an appearance and a bloom it would be difficult to parallel in the experiences of the past. The open season has culminated in the really fine weather of the last fortnight, marked by a temperature a long way above the average of January over nearly the whole of the British Islands and the greater portion of Northern Europe.

The outstanding feature of this singular weather is the extraordinarily high barometer which has accompanied it, an anticyclone of a very pronounced character and of great extent having overspread the Continent during this time. Starting from January 10, it is seen that the centre of highest pressure on that day was over Eastern France and Switzerland, in the centre of which pressure rose to 30·512 inches. On the 11th the area of high pressure increased and extended to eastward, retreating again on the 12th to the position it had occupied on the 10th, barometers remaining substantially at the same heights. On the 13th the centre of the anticyclone moved eastward to Prussia, pressure rising in the centre at Berlin to 30·903 inches; and on the following day the centre had advanced to Cracow with a pressure of 30·843 inches, whilst over well nigh the half of Europe pressure exceeded 30·700 inches. On the 15th the centre was found in the same position, but pressure had risen at Lemberg to 31·024 inches. On the 16th the anticyclone again retreated somewhat to westward, and at Wilna the pressure rose to 31·071 inches which is unquestionably one of the highest readings of the barometer ever recorded in this part of the earth's surface. On the 17th the centre occupied the region of the Alps, where at Berne, pressure was 31·012 inches; on the 18th it had retreated to westward so that the southern parts of England and Ireland were covered by it, pressure there being all but 31·000 inches. On the three following days, the anticyclone retained very much the same position, but the highest pressure in the centre fell successively to 30·093 inches at Oxford, 30·079 inches at Nottingham, and 30·076 inches near the Isle of Wight.

In vols. xxi., xxii., and xxiii., we took occasion, in reviewing the splendid series of International Weather Maps issued by the Meteorological Department at Washington, to point out and enforce attention to the important relations thereby disclosed between the distribution of atmospheric pressure, and that of temperature. The same relations have been observed during the past fortnight. Let our Daily Weather Reports be looked at from the 11th to the 16th, and it will be seen that the British Islands lay between the anticyclone which overspread the Continent with its high pressures, and a system, or systems, of low pressures out in the Atlantic; and that the barometric gradient was considerable during the time. With this arrangement of the pressure, southerly winds set in, characterised by a remarkable volume and persistency, and since owing to the great extension southwards of the anticyclonic area, they had come from a great distance, these winds were further characterised by a mildness and a warmth reminding one rather of the weather often experienced towards the end of September. The mean temperature of London for these days was 5°·6 above the normal, and in the Scilly Isles 6°·3.

On the other hand, as the anticyclonic area advanced on the south of England, the southerly winds gave way and were replaced with light winds and calms. The effects of terrestrial radiation now manifested themselves in a pronounced manner over the comparatively calm area, and the temperature of London markedly fell, and fogs began to prevail, as frequently happens under these conditions. On the 18th and 19th it was 5°·8 below the normal. At the same time our western and northern coasts were outside the calm anticyclonic centre, and within the outer region where moderate barometric gradients prevailed, and there, accordingly, southerly and south-westerly winds and high temperatures prevailed. Thus while in London the temperature was 5°·8 below the normal, it was 5°·2 above the normal at Mullaghmore, 6°·4 at Leith, 9°·2 at Wick, and 9°·6 at Stornoway. We have seen that the centre of the anticyclone advanced sooner on Lyons than on London, and there accordingly temperature fell sooner below the normal. Colder weather set in at Lyons on the 12th, at Paris on the 14th, London on the 17th, and the Isle of Wight on the 18th.

Over regions situated to the south of the anticyclonic

area, particularly to the south-east, northerly winds ruled, and as a consequence temperatures fell below the normal. Thus at Algiers during these days temperature was constantly under the mean, varying from 2°·9 to 6°·5, the whole period showing a mean deficiency of 5°·0; and from the 13th the mean deficiency was 3°·8 at Malta, and 5°·6 at Constantinople. On the other hand, over the north of Europe, which was during this time outside the calm anticyclonic centre, and marked with moderate barometric gradients, westerly and southerly winds prevailed, in some cases in considerable force, as on the occasion when a storm appeared in the Arctic Sea to the north. This region was therefore characterised almost throughout by abnormally high temperatures, the mean excess at Haparanda, at the head of the Gulf of Bothnia, being 21°·9 for the week ending Saturday last.

Thus, with barometers equally, or all but equally high the most diverse temperatures prevailed, the conditions determining the temperature in any locality not being the height of the barometer but the position of the locality with reference to the areas of high and of low pressure which prevailed over Europe at the time; or putting the result into the simplest words, it was not the height of the barometer, but the direction and force of the wind, which determined the temperature.

The highest barometer noted in the Weather Charts as having occurred in the British Islands during this time was 30·970 inches at 8 a.m. of the 18th at Oxford. Higher barometers than this even were recorded in 1808, at Gordon Castle, Banffshire, by Mr. James Hoy, he having noted 31·007 inches at 9 p.m. of February 24 of that year; and again 31·046 inches at 11 p.m. of January 8, 1820, this last reading being in all probability the highest reading yet recorded in these islands.

MR. MIVART ON THE CAT

The Cat. An Introduction to the Study of Backboned Animals, especially Mammals. By St. George Mivart, Ph.D., F.R.S. With 200 Illustrations. (London: John Murray, 1881.)

THE author of the present volume tells us in his preface that it "is expressly intended to be an introduction to the natural history of the whole group of *backboned animals*; but the subject has been so treated as to fit it also to serve as an introduction to Zoology generally, and even to Biology itself." By serving as a guide to the structure, as ascertained by dissection, and natural history of the cat, it will, it is hoped, "give the earnest student of biology the knowledge of anatomy, physiology, and kindred sciences which is necessary to enable him to study profitably the whole class" of Mammals, the natural history of these generally being, we are told, to be treated of in a companion volume.

After a somewhat careful study of the bulky volume of 550 pages before us, it is with some regret that we doubt if Prof. Mivart's intentions are likely to be realised, as, trying to attain two very desirable ends, it is not evident that he has succeeded in either.

The student of anatomy will, we think, find that much of the descriptive part of the present work is too sketchy to be of real service as a text-book of Mammalian anatomy, and the almost complete absence of references—even to Strauss-Durckheim's elaborate "Anatomie descriptive et comparative du Chat," published, with excellent illustrations, at Paris so long ago as 1845—also seriously detracts from its value in this respect. On the other hand, any one taking it up with a view to understanding the main principles and objects of biological science will, even if he succeed in his endeavour, be liable we fear to be disgusted by the large amount of "dry" and quite unreadable detail contained in it. Nor can we always speak very highly of the accuracy and style displayed in the volume in question.

After an introductory chapter, eight chapters are devoted to the consideration of the various organs of the cat, the anatomical structure of each system being accompanied by an account of its histology and functions. As already indicated, the descriptions of many of the parts concerned strike us as rather too brief and wanting in preciseness, whilst in some parts that we have tested we find considerable omissions. Thus in the account of the cranial nerves in Chapter IX. we find no mention of such interesting nerves as the vidian and recurrent laryngeal; in the myological portion, no account at all is given of the important subject of the nerve-supply of the various muscles described, which is only indicated later on when considering the distribution of the nerves themselves.

With regard to the histology of the various tissues, it would be more satisfactory as convincing the reader that it *is* the cat, and not some other mammal the structure of which is being described, if the illustrations were not so frequently taken from the pig or the well-known figures of Quain's Anatomy.

Chapter X. is devoted to the "Development of the Cat," and here it would have been still more desirable that the author should have stated explicitly how much, or how little, of its contents apply to the cat, or at least have given references to the authorities for some of his statements. The account given seems, as far as we can judge, intended to be a *résumé* of the principal facts ascertained as regards the development of *Mammalia* generally, but if so some of the views put forward are rather startling.

Thus on p. 320 we are told that "the first indication of the embryo is the appearance of a longitudinal depression or furrow, termed the *medullary groove*." Fig. 145, to which reference is made, pretty clearly shows that what is meant is, in reality, the *primitive streak* (in fact it is called, in the explanation, though *not* in the description, of that figure the "primitive groove")—a structure of quite a different order and significance, as surely Prof. Mivart must know, from the real medullary groove. The heart is said to be formed by "*one* vessel, tubular and rhythmically contractile"; in fact, in Mammals, as in Birds, it always arises from *two* tubes, which only unite subsequently (Cf. Balfour's "Embryology," vol. ii. pp. 522, 523). In the account of the development of the nervous system the statement made that "the white matter of the spinal cord is formed by transformation of the cells of the adjacent MESOBLAST" (p. 356), is quite opposed to all that we know of the development of that system in Vertebrates, and we are left to infer that the "mass of the nerves" are also derived from mesoblast, in contradiction to the observation and views of our most distinguished embryologists. The account of the deve-

lopment of the urinary organs and suprarenal bodies (pp. 350, 351) also leaves much to be desired.

After a chapter on the "Psychology of the Cat," Prof. Mivart devotes one to the different kinds of cats, living and extinct. Of the living species he recognises fifty, forty-eight of which are included in *Felis*, the other two being the two species of Cheetah (*Cynælurus*). We are glad to see that Prof. Mivart does not recognise the various genera *Leo*, *Tigris*, *Uncia*, &c., proposed by the late Dr. Gray, which have been adopted by some recent naturalists. The Ounce (*F. uncia*) is stated (p. 396) to occur near Smyrna; but we believe the sole authority for this is the identification by the late Mr. Blyth, who was followed by Gray, Jerdon, and others, of the *Felis tulliana* of Valenciennes with the true *F. uncia* of the central tablelands of Asia. According to the latest authorities *F. tulliana* is certainly *not* the Ounce, and is, in all probability, only a long-haired and pale-coloured Leopard (*F. pardus*).

Chapter XIII. is devoted to the "Cat's Place in Nature," a consideration of the relationships of the *Felidæ* to other Carnivora, and organic forms generally. In the enumeration of the characters of the three great groups of Fissiped Carnivora, we miss any allusion to their well-marked cerebral differences, clearly pointed out by Prof. Flower, and on which the late Prof. Garrod laid so much stress. "Aard-vark," we may mention, is the Dutch name for the *Orycteropus*, not for *Proteles*, as stated on p. 483. The cat's hexicology (or its relations to its environment) occupies the next chapter, and the concluding one deals with the problems of the origin and pedigree of the animal. In treating of the main zoological regions of the globe (pp. 497-500) it is not clear by what exact criterion Prof. Mivart has been guided in selecting forms representative of those regions. Neither mules (why introduce such artificial products as hybrids at all in such a connection?) nor chameleons can be considered as specially characteristic of the "Palæarctic" region, nor should we have noted the absence of "true grouse" or the presence of "the mocking-bird" as peculiarities of the "Ne-arctic" one. Why, too, call *Hyomoschus* the "aquatic musk-deer" (p. 498), when on p. 467 Prof. Mivart has correctly characterised the chevrotains as "very small animals, commonly called *in error* musk-deer"?

The book, we must add, is on the whole got up in very good style, both as regards type, paper, and illustrations. Of the latter there are over 200 woodcuts, many of them original, and including a nice series of figures of some of the less known species of *Felidæ*, as well as of skulls of some of the more remarkable North American extinct *Æluroidea*. It is to be regretted, however, that the volume should be disfigured by numerous misprints, most of them of well-known names. Thus we have *Potamagale* and *Potomogale*, *Arctitis*, *Mustilidæ*, *Amphinama*, "Hornedsenamer" (for -screamer), *Teniada*, *Gregorinidæ*, &c. Fort Bridger, a locality in Wyoming Territory, well known for its vertebrate remains, appears as Fort Bridges (p. 512) and also as "Fire Bridge" (p. 506)! Prof. Mivart, too, is not consistent in his spelling; thus we have Bali and Bally, and *Ai*lurus, *Ai*luropus, &c., succeeded almost immediately by *Ae*luroidea, Pseud*æ*lurus, &c. Lastly, it is a pity that the author does not always give his references in full, or even get the titles of the journals quoted correctly: thus on p. 331 we notice the "Quarterly Journal of Microscop*ic* Science, and Schäfer's Proceedings of the Royal Society" (*sic*).

W. A. FORBES

CRYSTALLOGRAPHY

Rammelsberg's Handbuch der Krystallographisch-Physikalischen Chemie. Vol. I. (Leipzig: W. Engelmann, 1881.)

THIS volume may to a certain extent be regarded as the first part of a new edition of Prof. Rammelsberg's two previous works on the same branch of science ("Handbuch d. Kryst.-Chemie, 1855; and "Die Neuesten Forschungen im Gebiete der Kryst.-Chemie," 1857). The development of its plan and the wealth of material entitle it, however, to rank as a new work, and has necessitated its division into two parts, of which the present one deals with the elements and inorganic compounds. Of late years much work has been done in the investigation of the physical properties of the artificial substances obtained in our chemical laboratories, the account of which is dispersed through the various scientific periodicals often in such a way as to render it all but impossible to find out whether any investigations have been made of the physical properties of a particular substance. The present work will therefore be highly welcome to both chemists and physicists who are interested in this their common province, and as a book of ready and easy reference will be a great boon to all researchers. The aim of the book is to give in as condensed a form as possible all the physical properties of artificial substances as far as they have been determined, in addition to the crystallographic characters which are often the only ones known. Thus the optical constants, the dilatation under change of temperature as determined by Fizeau, the electrical, magnetic, and other properties of each substance are given wherever known. In fact it aims at doing for artificial substances what has been already done for minerals in Miller's and Des Cloizeaux's "Treatises on Mineralogy." In addition the references to the original memoirs on each property are placed directly after the account of this property. Prof. Rammelsberg's reputation for the thoroughness of his work has been so long established that it seems almost impertinent to praise the excellent way in which he has here carried out his intention. He has produced a book which will not only be in every chemist's and physicist's library, but one which will be continually consulted by them. After dipping into the book in numerous places only one substance has been met with which seems inadequately treated, and this is antimony iodide, than which few substances are more interesting to the crystallographer. The account of the modifications and their relations is in this case scanty and imperfect, and the reference to Prof. Cooke's elegant research on them is wanting in precision.

Prof. Rammelsberg adopts the Weissian system of notation in his Crystallography, but this not in its entirety, as he uses sub-multiple—and not multiple—indices, as was done by Weiss. In the last paragraph of his introduction he states his opinion that the Weissian system is superior to those both of Naumann and of Miller, and he ends by declaring that crystallography would have been

much more studied by chemists had crystallographers avoided following the two latter distinguished men. It is difficult to understand such a view for, as far as descriptive crystallography is concerned, the Weissian and Millerian notations are practically identical except in the rhombohedral system, where different axial systems are adopted. The advantages of Miller's trigonometrical methods of calculation are acknowledged by many who, through long familiarity, invariably use the geometrical methods, and no one who is acquainted with both can hesitate as to the one he will employ.

The work is a fresh monument of Prof. Rammelsberg's indefatigable industry and skill in arranging and condensing a vast amount of material, and is a worthy addition to the long list of works on chemistry and crystallography with which science has been enriched by him.

OUR BOOK SHELF

The Encyclopædic Dictionary: A New and Original Work of Reference to all the Words in the English Language. By Robert Hunter, M.A., F.G.S. Illustrations. Vol. I.: A—Cab. (London: Cassell, Petter, and Galpin. No date.)

The Imperial Dictionary of the English Language: A complete Encyclopædic Lexicon, Literary, Scientific, and Technological. By John Ogilvie, LL.D. New Edition, carefully revised and greatly augmented. Edited by Charles Annandale, M.A. 3000 Engravings. Vol. I.: A—Depascent. (London: Blackie and Son., 1882.)

No better evidence could be adduced of the extent to which science has permeated modern life and literature than the prominence given to scientific terms in these two dictionaries. Words which a few years ago were confined only to technical vocabularies and were known only by specialists, are in these reference-books for general use found side by side with the vocabularies of Chaucer, Shakespeare, Tennyson, and Dickens. The many illustrations, too, are to a large extent derived from science, while the great advances recently made by a scientific study of language are shown in the etymologies. Mr. Hunter's undertaking is one of great magnitude, a combination of the dictionary and encyclopædia, an account of things as well as words. To judge from the first volume, it is likely to turn out a work of great practical utility. The vocabulary is as complete as could be desired, and the treatment of the various terms full, concise, accurate, and methodical. Mr. Hunter includes terms in the oldest English, and the scientific vocabulary is so full that it will be found of service even to specialists. The special terminology of botany, zoology, and chemistry is included, and, so far as we have tested, all those terms which have originated in the recent rapid advances of science. The numerous illustrations are carefully and nicely executed, and the etymologies give evidence of the study of the best authorities; though sufficient care is not always taken to distinguish between cognates and derivatives. Mr. Hunter has been "assisted in special departments by various eminent authorities"; indeed he could never have adequately carried out his undertaking without such assistance. We wonder, however, who his botanical assistant is. Under Botany we have a short history of the science, in which its classifications by various authorities are given; in Modern Botany, for example, we have first Lindley, then Thomé, and finally—"Robert Brown, jun."!

Ogilvie's Imperial Dictionary has held its place for about forty years, in spite of certain failings, especially in its etymology. It quite deserved the great reputation and popularity it had for so long, for it was really the most thorough and complete and practically useful dictionary in the language. It really, like Mr. Hunter's book, was a combination of dictionary and encyclopædia. It, however, greatly needed to be brought up to date, and this is what Mr. Annandale has attempted to do in the new edition, and the attempt has been successful. It is more concise than Mr. Hunter's book, both in vocabulary and definition, but on this very account may be preferred by many. It ranges over the whole of English and Scotch literature, and its scientific department is as full as the most exacting reader could require. The definitions are given with care and accuracy; the etymology is up to the latest research, and is concise and clear; the illustrative quotations show extensive reading, and the illustrations are thoroughly intelligible and neat. In its new form the "Imperial" is likely to meet with as wide acceptance as it did when originally published. Both dictionaries are excellently printed.

First Steps to a New Selenography; in which it will be recognised that the Moon was once an Inhabited World. By John Jones. (Dundee: J. Leng and Co., 1881.)

The title of this little book is hardly in accordance with its contents. For it is not *selenography*—the description of the features of our satellite—but *selenology*, the theory of the mode of their formation, that the author has taken in hand; and the inhabitants to whom he proposes to introduce us will be found to be by no means, as we might have expected, "men in the moon," but creatures of one of the lowest types of existence. We will not, however, quarrel with this. But we are obliged to add that the writer has attacked his subject in rather a peculiar way. Having come into possession of a good telescope, he has satisfied himself, from three nights' inspection of the Moon, that all former observers are in the dark, and that the real cause of her crateriform aspect is the building up of *atolls* of coral reef in oceans of volcanic mud, while the mysterious brilliant streaks are due to the friction and polishing of a glacial period. Various theories, as our readers may be aware, have been proposed to account for the wonderful aspect which our satellite presents in a telescope, and which is not unencumbered with difficulty; and the discussion, which has been going on for half a century, has by no means reached an uncontroverted solution. Nor can it be any disadvantage to the cause of truth that it should be thoroughly ventilated, and looked at from every point of view. But we must be forgiven for doubting whether the publication before us will advance the inquiry. We are loth to bear hard on any ingenious speculator, but we cannot persuade ourselves that the "crater-craze," be it right or wrong, will be "exploded" by the observations of three nights. And as to the possibility, alleged in the "Epilogue," that a meteor, "colliding with the extremities of projecting pinnacles of the lunar structures," might demonstrate the theory to our senses by transferring a fragment of coral reef to the surface of our globe, the author we hope will excuse us for preferring to wait for the messenger before we acquiesce in the theory.

The First Book of Knowledge. By Fredk. Guthrie, F.R.S. (London: Marcus Ward and Co., 1881.)

From the style of this little book we should judge that it is intended for the use of School Board teachers in giving Object Lessons. It gives in simple language an idea of the nature of common objects, and also of the mode of their composition. Of course from a man of such well-known ability as Prof. Guthrie we may be quite sure that the book will be perfectly accurate and thoroughly good so far as its subject-matter is concerned. The manner, however, in which the knowledge to be communicated is arranged is by no means to be unreservedly praised. In endeavouring to be simple Prof. Guthrie has adopted a

style which, to say the least of it, is clumsy, and which in many places is so unique as to be almost ludicrous. Prof. Guthrie calls every thing either a *stuff* or a *thing*, for instance, clay is a stuff and a brick is a thing, so then he goes on to tell what stuffs are and how they are made into things. The different subjects are very carefully arranged in chapters and paragraphs, and questions are given which would prove very useful for a class. Some of the descriptions of common objects are graphic, in other cases there is rather too much brevity employed.

A Lady's Cruise in a French Man-of-War. By C. F. Gordon Cumming. Two vols. Map and Illustrations. (Edinburgh and London: Blackwood, 1882.)

THOSE who have read Miss Gordon Cumming's "At Home in Fiji," recently reviewed in these pages, will be glad to meet with her again. The present work is more slight and sketchy than the former, but no less interesting. It consists of a series of letters written from day to day during a cruise on board a French man-of-war, in the autumn of 1877. Miss Cumming was the guest of the French Bishop of Samoa, and accompanied him on his visits to the churches on various South Sea Islands. In this way she visited the Tonga, Samoa, and the Society Islands, making a specially long stay in Tahiti, and everywhere received with the warmest hospitality. Besides the genuine interest of Miss Cumming's narrative, it is valuable as giving a very full idea of the present condition of the islands visited. She has also a naturalist's eye for geology and botany, and has occasional interesting notes on the products of the islands. The cover of her book is a novelty, and its delicate colours make one afraid to handle it. It bears a coloured illustration of the beautiful climbing fern, which twines round trees and shrubs in the Pacific Islands, and is called by the natives "Wa Kalou" (God's Own Fern).

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Mid-day Darkness of Sunday, January 22

IT is to be hoped that you will receive many and good accounts of the wonderful, perhaps unprecedented darkness which obscured London for some three hours on Sunday last, in order that its range may be localized.

It appears to have commenced about $10\frac{1}{2}$ A.M., though I cannot vouch for it, as I had been up till near dawn, and was not roused till near noon. Then truly it was hard to believe the clock! To all practical intents and purposes it was night; only the street lamps remained unlit. This however enabled one to realize more fully the wonderful absence of all ordinary daylight in the streets. After the first surprise, it occurred to me to note such facts as would hereafter constitute evidence. In the first place I sought to establish that the phenomenon was not an ordinary thick London fog; secondly, to find some striking measure of the darkness, in one's immediate vicinity. A third observation offered itself in corroboration of both. These I will give in detail.

Looking out of a firsr-floor window, eastwards, I had on the right towards the south the sharp tall spire of Langham Church, clearly visible (at a distance of 65 yards) against the darkly lurid background afforded by the distant fog behind, which must have been the sun, then near the meridian and at about the proper elevation, but of course quite invisible. The clearness of the outline showed how slight was the fog—at any rate below the level of its apex. Next, looking across the street, fourteen yards from wall to wall, the gas-lit interiors opposite were all plainly visible—blinds not being down, nor curtains drawn, in London, during the daytime, even if the gas is lit. It was *obvious* that there was no fog to speak of. Next, as to the darkness: I say that the street lamps were not lit; consequently this observation was easy. I remarked that though one could *hear* the passers-by on the opposite pavement, they were *quite invisible.* I could only see the lower limbs as they crossed the dim lights in the opposite basement windows. Lastly, looking northwards, where a turn of the street brings a line of four-storied houses across the line of sight, at forty-five yards distance, many of the windows where the occupants were not at church, being lighted from within, were easily seen; but there was *not the faintest sky-line:* the sky, or rather background of foggy air, was utterly devoid of illumination. The windows alone stood in evidence that there were houses there, *not* obscured by fog.

Finally, so strong was the impression of *mere darkness* that, having sat down to write, I started up and went again to the window, with the ejaculation—"Why, one ought to see the stars!" and I should hardly have been otherwise than satisfied if I *had* seen some.

Others may have seen this kind of thing in London before. Certainly I have not; and I have a strong impression that if it had happened on a week day, instead of on a Sunday during the morning service, we should have had a storm of complaints from the City, which even the *Times* would have noticed!

1, Langham Street, January 24 J. HERSCHEL

Earth-Currents

A REMARKABLE and unusual sudden appearance of earth currents occurred between 10.15 and 10.20 p.m. Greenwich time on the evening of January 19, on lines running east and west. They disappeared as rapidly as they arrived. They were weak, measuring, when at a maximum, 3.3 milliamperes. Traces remained until 10.50. It will be interesting to learn if simultaneous disturbances occurred in our magnetic observatories. I have not heard of any aurora being visible that night.

January 24 W. H. PREECE

The Storage of Electricity

WE have heard a great deal of late in reference to what is called the storing of electricity, and not long since we had a long account in the *Times* of the journey from Paris to Scotland of a gentleman who carried with him a number of cells "filled with electricity," and representing "hundreds of thousands of foot-pounds of force." The daily papers and the scientific serials have vied with each other in telling how electricity can be stored, or bottled up and transported from place to place, to be drawn upon as circumstances may demand. The result is that the majority of those practically unacquainted with the subject have very false ideas as to the nature of the Planté, the Faure, or the Sutton accumulators. In no sense of the word can these beautiful forms of batteries be called storers of electricity. A man who should carry with him a piece of copper, a piece of zinc, and a little sulphuric acid, and should then boast that he was transporting electricity from place to place, or carrying half-a-dozen thunderstorms in his pocket, would be rightly regarded as committing an abuse of language. A man who carries a box of lucifer matches in his pocket has no right to say he is transporting fire from place to place, or to speak of them as storers or accumulators of fire. In like manner it is an abuse of language, to speak of electricity being carried from place to place, or stored up for future use in the Faure secondary battery. Nor is it less incorrect, or less misleading to speak of "charging" such batteries with electricity. The dynamo machine may render the amalgamated lead and copper of a Sutton battery capable of being unequally acted upon by sulphuric acid, and of thus giving rise to an energetic current of electricity, and the reversing action of such batteries is undoubtedly very beautiful and certain to be of the greatest possible practical convenience, but there is nothing in the principle of their action to justify the very misleading language used in reference to them, not only by writers to the provincial press but by scientific men in high-class journals. Practical electricians understand generally perfectly well what they mean by the figurative language they use, but it would be well, if in lectures and articles of a didactic nature, or intended for the information of the general public, they were to use language of a less metaphysical character and to describe a thing as it really is. It is because as a teacher I know how apt people are to give a concrete significance to abstract or figurative expres-

sions that I ask you to find room in your pages for this short protest.

EDMUND P. TOY

Middle Class Schools, Littlehampton, January 13

A Solar Halo

A PHENOMENON quite unusual in these parts was witnessed here this morning in the form of a solar halo of surpassing brilliancy. The outer ring was dazzling white; the next pale lemon, the inner orange, and the inclosed space grayish brown, uniform throughout. The display was brightest at sunrise. The sky was clear with the exception of a few light clouds along the eastern horizon. The air was still. The temperature was ten degrees below freezing point. As the sun climbel higher the colours gradually faded out, until at 10.30 the last traces had disappeared.

J. T. BROWNELL

Mansfield, Pa., U.S.A., January 10

Coltsfoot

THERE is an interesting article on "Coltsfoot" in the *Pall Mall* for January 21, in which mention is made of fifty-two species of wild flowers being in bloom at Lyme Regis; "and at Hastings nearly one hundred have been counted within a semicircular radius of 10 miles." Coltsfoot is amongst the flowers already in blossom on the south coast; and it is instanced as a very remarkable proof of the mildness of this winter. I think it is nearly as wonderful that *Corylus avellana*, the common nut, should be in blossom on a sheltered bank in North Wiltshire. Not only are the catkins fully in blow, but the fertile flowers are also in blossom, and that not only on one, but on many bushes. A wood full of primroses such as we often wait for till March or April is another instance of absence of frost.

T. S. MASKELYNE

Salthrop, Wroughton, Wilts., January 23

The Absolute Sine Electrometer

IN my paper in last week's NATURE (p. 278), read "$\frac{1}{50}$ inch pitch" instead of "$\frac{1}{10}$ inch pitch" for the micrometer screw. The diagram has been turned round counterclockwise.

Cooper's Hill, January 21 GEORGE M. MINCHIN

PEDICULI.—A correspondent asks if any one can inform him whether in experimental researches on spontaneous generation pediculi have ever been the subjects of observation, and if so, with what results? Further, is it likely that the density of their dermal structures affords them a means of resistance to heat applied through a liquid medium?

PHYSICAL NOTES

DR. R. KÖNIG has recently described a method of investigating the nodes in the vibrating column of air in an organ pipe. The pipe—a large one—is laid horizontally on its back, and a long slit is made the whole length of the pipe. The slit is closed by water, the pipe lying in a trough. A small curved tube, open at the end, passes down through the water and up through the slit into the pipe. Its other end is joined to a manometric capsule in conjunction with a flame apparatus of the usual type. The nodal surfaces can be determined to within two millimetres. The introduction of the tube interferes less with the conditions of vibration than the introduction of a tissue-paper disk or other explorer hitherto used.

A NEW barometer, automatically recording the variations on an enlarged scale, has been invented by Marshall Delaey (*Bull. Belg. Acad.*, No. 8). It has the following arrangement:—The barometric tube, having a capacious reservoir at top, is fixedly suspended. The cistern is a tube slightly wider and nearly as long; it bears on one side an index, and on the other a pencil working on a moving cylindrical surface, and it forms the upper part of a kind of areometer, having a downward extension in the form of a closed tube floating in mercury in a wider tube, which communicates below, through a U-tube, with a wide and shallow covered cistern, the level in which is approximately constant. The variation of pressure is marked by the variation of the height of mercury in the reservoir, and this latter is to that of the total height in the barometric cistern (or to the path of the float or of the pencil) in the ratio of the section of the cistern to that of the reservoir (a sixth in the instrument the author represents). Thus an amplification is realised.

THE colourless fluorspar of Switzerland, according to M. Cornu (*Jour. de Phys.*, October), is a substance at least as transparent for ultra-violet rays as quartz, and its law of dispersion is so much in harmony with that of quartz that with the two a system of lenses of nearly perfect achromatism may be had. To give an idea of this achromatism M. Cornu states that he obtains on one *cliché*, with very satisfactory distinctness, the spectrum of all the photographic lines of metals, from the three blue lines of zinc to the lines No. 32 of aluminium. With such objectives a determination of the wave-lengths of very refrangible radiations becomes possible. The author describes measurements of this kind (along with details of method) in the case of magnesium, cadmium, zinc, and aluminium.

A RHEOMETER, for measuring currents at different depths in water, is described by Signor Scardona in the *Rivista Scientifico-Industriale* (September 30). It acts by pulses generated at intervals (according to the speed of the current) in a tube, and affecting a bell. The water-current acts on two screw-vanes on a horizontal shaft in a case attached to a vertical rod. This shaft (which a flat vane keeps in a line with the current) actuates, at intervals, through an endless screw and a reducing system of wheels, a lever applied to a caoutchouc capsule at the end of a metallic tube, through which, and a flexible tube attached, the resulting pulses pass to the bell-arrangement (which is in a portable case). The rod and the metallic tube are each made up of several pieces screwed together, and the vane case and tube can be fixed at any part of the rod. The advantages claimed over Amsler's rheometer are simplicity (in dispensing with electrical action), and a better kind of signal (one stroke of the bell for each turn of a wheel).

AN experimental inquiry by Herr Graetz (*Wied. Ann.* No. 10) into the heat-conductivity of gases and its relation to temperature results as follows:—1. Heat-conduction in the gases air, hydrogen, and (with low temperatures) carbonic acid, consists in transference of progressive energy only; intramolecular energy contributes immeasurably little. The molecules thus behave like material points. 2. The relation of heat conduction to temperature is found by experiment to be such (approximately) as Clausius' theory requires. 3. All results for gases and vapours, showing divergences from the values calculated from theory, are without evidential force, for they only gave the apparent heat-conducting power, in consequence of absorption of radiant heat. 4. The divergence of the temperature-coefficient of friction from that calculated from theory cannot have for cause (or not alone) the decrease of the molecular diameter with rising temperature; some other explanation must be sought.

A USEFUL comparison of the numerous determinations of the expansion of water by heat is made by Herr Volkmann in a paper contributed to Königsberg Institute (*Wied. Ann.* No. 10). Experimenters, it is known, have used two methods—the hydrostatic and the dilatometric. The author gives in a table the average values for volume and density of water (deduced from the observations of Hagen, Matthiessen, Pierre, Kopp, and Jolly) for all temperatures from zero to 25°; also the volumes every 5° from 25° up to 100°. The temperature of greatest density of water is, according to the best data, + 3·94° C. Herr Volkmann thinks there is no occasion to study the subject anew on the lines hitherto adopted; but it might be well (in his opinion) to observe the absolute expansion of water in the same way as Regnault determined that of mercury (with communicating tubes).

IN view of assertions that the band-spectrum attributed to hydrogen by Herr Wüllner is really that of a hydrocarbon—acetylene according to Herr Ciamician—the former physicist has made a careful examination of the acetylene spectrum (*Wied. Ann.* No. 10), and finds that, as might be expected from the higher proportion of carbon in acetylene, its spectrum differs from that of hydrogen much more than do the spectra of ethylene and marsh gas. While in these latter the characteristic carbon bands indicate the spectrum to be that of a carbon-containing gas, the whole of the red, orange, and yellow part, in the other, resembles much more the spectrum of carbonic acid than it does that of hydrogen.

THE physical properties of indium have been very little known hitherto. A recent contribution on the subject by Herr Erhard (*Wied. Ann.* No. 11) treats of some of its electric properties. As regards resistance, he finds that indium is like some other metals in not coming under the often-accepted rule that pure metals have a change of coefficient of resistance with tempera-

ture corresponding to the absolute temperature. The thermo-electric position of iridium among seven other metals for temperature-differences 0° and 98°·6 is thus indicated—

− Al, Sn, In, Zn, Ag, Au, Cu, Fe +

with smaller differences (0° and 5° or 10°) it comes after Au Zn. Once more, elements were constituted of indium in its chloride with zinc, copper, and iron in their chlorides, and examined. In the element indium-zinc, the indium is the positive pole; in the two others the negative. The electromotive force of In/Zn was found equal to 0·331 Daniell; of Fe/In = 0·160 D., and of Cu/In = 0·584 D.

IN a paper communicated to the American Association for the Advancement of Science Dr. E. L. Nichols discusses the relation between the electric resistance of platinum and its coefficient of expansion by heat. He has made careful experiments by an ingenious method at temperatures rising up to 3000° C., and finds that all the empirical formulæ given previously by Siemens, Matthiesen, and Benoit are unreliable, and, from certain anomalies in the behaviour of the metal he concludes that it is safer to infer the temperature from its expansion than from its electric resistance.

TORNADOES, WHIRLWINDS, WATERSPOUTS, AND HAILSTORMS[1]

II.

THE *Dust Storm* of India and other dry, hot climates, is another well-marked type of the whirlwind. The observations and illustrations of these meteors, which have been made by Baddeley and others, are in a high degree instructive from the light they throw on the actual movements of the whirlwind which the dust-laden air-currents of the storm present in a visible form to the eye.

Previous to the outbreak of a dust storm, the atmosphere is unusually calm and sultry, thus essentially resembling the conditions of weather under which the tornado and whirlwind originate and which point to a vertical disturbance in the equilibrium of the atmosphere. The simplest form of the dust storm is that of a tall aërial column of sand moving onwards, and drawing into itself as it whirls round in its course, dust and other light bodies within the sweep of the strong air-currents which blow along the surface and converge vorticosely round the base of the column. A frequent form is shown in Fig. 4, which represents several dust columns grouped together, each whirling independently round its own axis with incurving air-currents at the base, whilst the group is bodily borne forward, presenting remarkably striking aspects as the forms and relative positions of the columns are changed. While engaged early in 1851 in the investigation of dust storms, Dr. Baddeley followed one on horseback, and was fortunate to note several of the important phenomena of these storms. As the dust storm passed various objects in its course, such as tents, horses, &c., it gradually diminished in size, till instead of a whirling circle of five or six feet in diameter, composed of several rotating eddies, or spirals of dust, such as are seen in Fig. 4, it terminated in a single cone, the apex of which in contact with the ground, rotated briskly from left to right, just as the whirling composite circle had done. From the cone of dust, a long ribbon-like band about a foot across, of equal dimensions throughout, extended into the atmosphere as far as the eye could see, but as its sides presented a greater opacity than the central portion it was really of a cylindrical form. This column was rendered visible by the dust it had whirled aloft, and was further observed to exhibit by the light of the sun which shone through it, a kind of vermicular spiral motion. Aloft the column extended forwards in advance of the whirling cone. Suddenly the lower portion of the column which continued to rotate to the last vanished, and the upper portion then slowly receded upwards and onwards till it passed out of sight.

The important character of the evidence adduced by the observations of dust storms towards a correct understanding of the whirlwind consists in the circumstance that it affords conclusive evidence that there is a strong inflow of the air along the surface of the ground all round vorticosely towards the base of the whirlwind, and that these same inflowing air-currents thereafter ascend through the air along the centre of the whirlwind, carrying with them the evidence of their ascent in the visible solid particles of dust, sand, and other light objects they whirl up with them in their upward course.

The most marked difference between the dust storm and the waterspout or tornado lies in the essential difference, as regards moisture, of the masses of air which are drawn into and ascend the columns of the whirlwinds. In the waterspout, certainly in all waterspouts that reach down to the surface of the earth, the earth is at, or not far from, the point of saturation, and in these cases the whirlwind is accompanied with heavy rains. In some instances the rainfall has been so excessive that it can fittingly be described as only an aërial torrent of solid water, that from the velocity with which it falls from the clouds digs

FIG. 4.

deep openings in the soil at the points where it strikes the ground. Thus immediately after the great tornado which occurred in Pennsylvania in June, 1838, Espy visited the spot and carefully examined the sides of the ridges and mountains on which its chief force was spent. He found many holes dug out by the torrents of water shot down by that tornado, which measured about thirty feet in diameter and from three to six feet deep, according to the nature of the soil and depth of the rock; the sides of the holes being in most cases cut down almost perpendicularly on their upper side, but entirely washed out on their lower side, so as to form the commencement of a ravine.

On the other hand, the air-currents which enter into and rise through the columns of the dust storm are very dry, and far removed from the point of saturation. Hence a large number of dust storms are neither accompanied nor followed by rain or any aqueous precipitation. Not a few, however, are observed to be followed towards the close of the storm with a sudden fall of rain, occasionally little more than a sprinkling, which may be due either to the condensation caused by the extreme rarefaction resulting from the rapidity of movement of the gyrations of the ascending air-currents, or to the great height in the atmosphere to which the air-currents are carried by the storm.

[1] Continued from p. 157.

Certain tracts of the ocean are known by the absence, or comparative absence, of rain, such rainless regions of the ocean being included within what may be called permanent anti-cyclones; that is, tracts of sea over which atmospheric pressure is higher than it is all round. Such regions are also remarkable for peculiarly bright clear skies and strong sunheat. Similarly the anti-cyclones which occur between, or in the immediate neighbourhood of cyclones are characterised by dry air and clear skies; and it is under such conditions that the strongest direct sun-heat is experienced. When in the warmer months of the year these anti-cyclones remain practically stationary for some time, which at that season of the year not unfrequently happens, it follows that the lowermost strata of the atmosphere become abnormally heated; thus bringing about a vertical disturbance of the equilibrium of the atmosphere, out of which whirlwinds originate. It is under these conditions, in all probability, that *white squalls*, or *fair-weather whirlwinds* occur, the originating cause of this special form of the whirlwind being the great dryness of the air due to its place in the anti-cylone, and the abnormally rapid diminution of temperature with height owing to the strong insolation through the clear, dry atmosphere. Any cloud that may happen to be formed is at a great height. The character of the cloud, also, and the commotion and boiling of the sea which is observed immediately under it, and accompanies it as it moves onward in its course, are clear proofs that the interspace between the sea and the cloud is filled with the gyrations of the rapidly-ascending air-currents of a whirlwind, which does not appear as a water-spout simply because the air of the ascending currents is too dry or the gyrations of the whirlwind are not sufficiently rapid to bring about condensation of the vapour into visible cloud.

One of the best marked of the permanent anticyclonic regions of the globe is that large region of the Atlantic which lies to the west of Northern Africa. Over this wide tract of ocean the portion most liable to be struck by the white squall or the tornado will evidently be where the general drift of the wind issuing from the anticyclonic region is approximately antagonistic to the prevailing wind as observed at the surface. During the summer months, for example, no such antagonism exists between the winds of Florida, the southerly winds prevailing there being in accordance with the general drift of the winds for that side of the anticyclonic region of the Atlantic on the one hand, and on the other in equal accordance with the monsoonal wind of that coast towards the heated interior of the Southern United States. Quite otherwise, however, is it with the ocean off the west coast of Northern Africa. There the general drift of the winds over that part of the region overspread by the Atlantic anticyclone is north-easterly; and that this wind prevails at no very great height is abundantly shown by the quantity of African dust which falls on this part of the sea; whereas the surface wind is from the south-west, being strictly monsoonal in its character, or is an inflow towards the heated interior of North Africa. This is the region of the *Bull's-eye Squalls* of the African coast—a form of the whirlwind which deserves to be more accurately described and investigated than it has yet been, from its evident relations to the two great wind-systems referred to above, and to the very different states of atmosphere, which these imply over the restricted region where the bull's-eye squalls occur.

The white squall accompanies fine weather, and is preceded immediately, and for a space of time more or less extended, by a clear sky and calm, or all but calm, weather. Its appearance is sudden, its duration brief, but its destructive power is occasionally so dreadful, that it has been known to strip a ship of every sail and mast in a few seconds, and leave it lying a helpless log amidst the tremendous seas which follow it. It is not possible, when sailing through a region overspread by the anticyclone, to make the outlook too close and sharp, particularly when the weather looks singularly fine, the skies beautifully clear, the air calm or all but calm, and *the temperature and moisture of the air noticeably high*.

On May 17, 1763, Cook saw six waterspouts on Queen Charlotte Sound, in one of which a bird was seen, and in arising was drawn in by force and turned round like a spit; an important observation, as Prof. Ferrel remarks, as showing that there is draught and an inflowing of air from all sides to supply the ascending current. In other words, the behaviour of the air-currents of a waterspout is precisely that of the air-currents of a duststorm, as actually seen in its dust-laden currents.

Another observation of great importance was made by Prof. F. E. Nipher, near Schell City, Missouri, and published in NATURE, vol. xx. p. 456, which, from its great importance in the study of whirlwinds, we here quote:—

"While making magnetic determinations at Schell City, Mo., a whirlwind of some violence passed near our tent, moving with the characteristic swaying and halting motions of the tornado. Its base was quite pointed, and about 2 feet in diameter.

"Unlike those seen last year, and described in NATURE about a year ago, there were no surface-winds strong enough to bear dust along the surface of the ground, but the dust carried up in the vortex was collected only at the vertex of the whirl. The dust-column was about 200 feet high, and perhaps 30 or 40 feet in diameter at the top. The direction of rotation was the same as that of storms in the northern hemisphere. Leaving the road the whirl passed out on the prairie, immediately filling the air with hay, which was carried up in somewhat wider spirals, the diameter of the cone thus filled with hay being about 150 feet at the top. It was then observed, also, that the dust-column was hollow. Standing nearly under it the bottom of the dust-column appeared like an annulus of dust surrounding a circular area of perfectly clear air. This area grew larger as the dust was raised higher, being about 15 or 20 feet wide when it was last observed. This whirl could be observed half a mile, finally disappearing over a hill."

Hence in this whirlwind the behaviour of the wind was exactly what is seen to obtain in the dust-storm. The light objects on the surface of the earth were lifted and carried up in whirling gyrations with a velocity so considerable that the hay and dust were driven outward by the centrifugal force of these gyrations to some distance from the axis of the whirlwind, leaving round the axis a shaft of perfectly clear air, the diameter of which gradually increased as the gyrating air-currents ascended, and friction was thereby diminished. An increase in the velocity of the ascending gyrations would, if sufficiently great to produce the required rarefaction, have filled the clear axial shaft of the whirlwind with cloudy vapour.

ELECTRICITY AT THE CRYSTAL PALACE

I.

THE work of installing the apparatus and machines at the Crystal Palace Electrical Exhibition is progressing very slowly, owing perhaps to the absence of any formal day of opening to hasten it. Before everything is fairly in its place, at least another fortnight will have elapsed, for a great deal of time is necessarily consumed in making electrical connections. Enough has been done, however, to give a fair idea of what the exhibition will be like. The official catalogue has been published in advance, and there are about five hundred exhibitors enumerated in its pages. Of these only about a hundred are from abroad, including America, so that the exhibition is rather an English than an "international" one. At the Paris International Exhibition of Electricity there were over two thousand exhibitors, and of these only one-half were French, the remainder being from every other civilised country, including Japan, which offered the first fruits of its electrical science in the shape

of some porcelain telegraph insulators, and battery pots of porous clay. Comparison with the famous show at Paris is naturally provoked by the public statements which have been made, to the effect that the Sydenham exhibition will be equal, if not superior to that in the Champs Elysées, but there is really no comparison between the two displays. It is not merely in the number and variety of the exhibits that the difference is so marked; but in the arrangement of the whole, and the intrinsic value, ingenuity, and workmanship of the articles exposed. The Paris exhibition was a compendium of all that electricity had achieved since it became a science, and the visitor could there see within the compass of a single building the rough experimental apparatus with which all the great discoveries in electricity had been made, and the most powerful and magnificent effects which modern invention has elicited from them. Everything had been done by the exercise of French taste to make the exhibition as interesting and attractive as possible. A lighthouse, a model theatre, a picture-gallery, had been erected to show the capabilities of the electric light; the powers of the telephone were exemplified by means of a "salle d'audition," where visitors could hear the music of the Grand Opera and the elocution of the Comédie Française; an electric boat plied on the waters of an ornamental basin; an electric balloon was propelled through the air; and a great diversity of machines were put in motion by the electric current from sewing-machines and fans, up to hammers, pumps, and printing-presses.

There is no good reason why the English exhibition should not have been equally interesting and instructive if it had been carried out under happier auspices. To begin with, the time was ill-chosen, following, as it did, hard on the back of the Paris one, when foreign exhibitors had grown tired of exhibitions, and were eager to return to their homes. A year hence would have been a better time; and the response of foreign electricians would doubtless have been heartier. Moreover, the Crystal Palace is not well adapted for such a purpose. It is too far out of London, and being above all a place of entertainment, is out of keeping with a scientific exhibition. The truth is that there is a clear need of a large building in London for exhibition purposes. We have no Palais de l'Industrie as yet, and hence we are obliged to hold our industrial exhibitions in such places as the Agricultural Hall, which has by no means a central site, or the narrow galleries surrounding the Horticultural Society's Gardens, where the apparatus of the Smoke Abatement Exhibition is now very inconveniently crowded. We require for London a commodious and elegant glass and iron structure, of a permanent kind, situated somewhere in the West End, either in Hyde Park or the Green Park, where it would be readily accessible to all. Until we have such a building, our exhibitions, in this age of exhibitions, will never show to good advantage.

Taking the Crystal Palace Electrical Exhibition for what it is, and not for what it might have been, we shall still find plenty to interest us there. The four great divisions of applied electricity, telegraphy, telephony, electric lighting, and the transmission of motive power by electricity, will be represented, and in telegraphy and electric lighting very worthily represented on the whole. Great Britain has played a leading part in the development of the telegraph, and the fruits of her enterprise and ingenuity are visible on the Post Office stall, and the exhibits of the great submarine cable companies. The Wheatstone automatic instrument, which is the most rapid telegraph for overland lines, is shown at work by the Post Office, and the Eastern Telegraph Company exhibit Sir William Thomson's beautiful Siphon Recorder, which is the finest apparatus yet invented for receiving messages through deep-sea cables. The stalls we have mentioned, together with that of the War Office, are situated in the great nave of the Palace; and the galleries at the west end are also set apart for various exhibits. Fully one-half of these are in their places, and a number of interesting objects are on view. We shall have occasion to refer to some of these stalls at greater length in subsequent articles, but at present they are incomplete.

The display of electric lamps promises to be very good, partly owing to the magnificent vista offered by the grand aisle of the Palace, and the varied objects below, such as ferns, flowers, statuary, and gaily-coloured wares. Visitors will have a rare opportunity of seeing how brightly the various tints appear in the electric light, more especially the green of foliage, owing to the prevalence of actinic rays in the electric arc. It is for this reason that landscape paintings appear doubly natural when lighted by the rays of a "lampe soleil" or Werderman lamp; and on the other hand that flesh tints are apt to seem too purplish. The purely incandescent light such as that of Swan or Edison has a yellowish tinge, which produces a scenic effect more resembling the deadening of gas light, and it is therefore not so well adapted to light a picture-gallery, or the tableau of the stage, as the electric arc or Drummond limelight.

The entire nave will be lighted in sections by arc lights, of different kinds, such as the Siemens', Brush, Jablochkoff, Pilsen, Gravier, and Crompton lamps. The incandescent lights of Swan, Lane-Fox, and Edison will be shown in the courts and enclosures within the Palace; for example, the Alhambra Court, which will be lighted by a crystal chandelier of Lane-Fox lamps hung over the fountain, and the Entertainment Court, which is now being fitted up with a splendid chandelier of a hundred Edison lamps of sixteen candle-power. This brilliant fount of light resembles an enormous basket of flowers, tulips and convolvuli, each arching over towards the observer and displaying between the coloured petals a luminous globe as if it were an enlarged pistil. The stems of the flowers are of gilt brass, the petals are of pearl and opalescent glass; while the pistil is of course the pear-shaped bulb of the incandescent lamp. The Concert Room has been lighted every evening for some time past by Edison lamps swung in festoons from the pillars, or suspended in stars under the galleries, and clustered in two chandeliers hung from the roof. One of these is a small copy of the larger flower basket in the Entertainment Court, and the other is a sac of crystal lustres gleaming here and there with lamps. Altogether the designs of these fittings reflect great credit on Messrs. Verity and Co. of Covent Garden.

EDWARD WILLIAM BINNEY, F.R.S., F.G.S.

THIS eminent geologist was born in 1812 at Morton, in Nottinghamshire. He was descended from a long-lived and robust stock of men, very few generations taking the family back long before the times of the Great Rebellion One of the American branch, the Hon. Horace Binney, with an interest in strange contrast with the indifference commonly felt about such matters in this country, has taken much pains in tracing the origin of his ancestry. Perhaps it will satisfy most persons to know that the father, Thomas Binney, born in the year 1762, was a much respected gentleman, diligent in business, and of the strictest integrity. He was a maltster, often travelling to Manchester, where one of his principal customers was the grandfather of the writer of this article. He died in 1836. Young Binney received his education in a grammar school, conducted on principles of severe discipline, so different from the modern *régime*. He then served his apprenticeship to a solicitor in Chesterfield. Other pursuits soon occupied his attention, but his legal knowledge was afterwards of the greatest service to him in the commercial portion of his career.

From an early age he was a keen observer of the

operations of nature, and took great interest in philosophical pursuits generally; hence soon after settling in Manchester he sought admission into the Literary and Philosophical Society; his election, on January 25, 1842, taking place by a singular chance on the same day with Dr. Joule's and Dr. Schunck's, subsequently sharers with him in the honours of the presidency. In this Society, so congenial to his tastes, he was a leading spirit. It was mainly owing to his energy that the Society was maintained in its position as a publishing institution, and to it many of his more important papers were addressed.

One of the earliest of these was in 1843, when he read a paper entitled "An Account of the Petroleum found in Downholland Moss," showing that petroleum could be produced from the decomposition, or rather distillation of peat at a low temperature. Little was before known of the origin or utility of this product. In the inquiry he was associated with Mr. W. H. Talbot, who assisted him in making the bores and obtaining information respecting the moss. The following is extracted from Mr. Binney's statement to the Philosophical Society (*Proceedings* of the Society, vol. viii. p. 136). "On the 26th November, 1848, I went to Downholland and showed the deposit to Mr. James Young, and explained to him how the petroleum was there formed. This was before I accompanied that gentleman to Riddings, at Easter, 1849, and went down Mr. Oakes's pit, where the deep coal was wrought, and petroleum flowed from the roof. At both those places the supply of petroleum was not sufficient for commercial purposes on an extensive scale. The Bathgate works were the cause of the petroleum trade in America. In Scotland paraffin oil was first made on a large scale and introduced as an article of commerce. In the suit of Young *v.* White and others, tried at Westminster in 1854, the circumstances under which Mr. Young first became acquainted with the petroleum at Riddings were given to the public. Of course when the Americans saw the report of that trial they ceased to import high-priced Boghead coal from Scotland, upon which they had to pay a patent right for the manufacture of paraffin oil, and immediately resorted to petroleum, which had been running to waste for ages."

The name "paraffin," adopted by Mr. Binney, was a principal means by which the patent was established.

The successful commercial enterprise thus commenced did not alienate Mr. Binney from the pursuit of science. Besides his paper "On the Origin of Coal," December 1, 1846, he made elaborate investigations on Permian and Triassic Strata; on building stones, of which he made the collection in the geological museum which he was mainly concerned in establishing, and filling with specimens of his own collecting; the drift deposits of Manchester and its neighbourhood," &c., &c. From the last-named paper I extract a paragraph indicating his love of the subject:—"The examination of the older fossiliferous rocks, rich with the remains of organic life, has generally attracted the attention of geologists, to the exclusion of the drift, which has been but too often considered as a dry and uninteresting study. My intention is to attempt to dispel this delusion. However delightful it may be to the human mind to examine the 'medals of creation,' as Cuvier aptly denominated fossil organic remains, and to trace back through countless ages the successive races of beings that have formerly peopled this globe—performed the parts for which they were designed, and then ceased to exist; to investigate the various forms of vegetable life that deprived the atmosphere of its surplus carbon, for the double purpose of forming our invaluable beds of coal, and at the same time fitting the air for the respiration of animals of a higher order; and to examine the wonderful chemical agencies that have been in operation in the great laboratory of nature, in order to prepare our metallic and mineral treasures; still, the last great physical causes which have operated on the face of the globe, and adapted it for the habitation of man, deserve our attention in an equal, if not more pre-eminent degree.

"It is to this last and finishing stroke of the Creator that the earth chiefly owes its present arrangement of land and water, its beautiful variety of hill and dale, and its different kinds of soils for the support and nourishment of the vegetable kingdom—that wondrous agent for the conversion of brute into organic matter, which fits it for food for the use of the animal creation, and man himself." ("Manchester Memoirs," vol. viii. N. Ser. p. 196).

Mr. Binney had great sympathy with all earnest intellectual labourers, particularly with those of straitened means, and it did not matter much with him in what field their energies were displayed. Thus among those he helped with his counsel and assistance, Sturgeon, to whom we owe so many first steps in theoretical and practical electricity, is a striking example. It was through Mr. Binney's exertions that this singularly gifted man was rescued from poverty and received Government recognition of his discoveries. Then there were Butterworth the geometrician, Bamford the poet, Richard Buxton the botanist, and many others, whom he cared for with almost a paternal solicitude.

Sixteen years ago he purchased Ravenscliff, in the Isle of Man, and there he spent a large portion of his time, showing much hospitality to men of kindred tastes to his own. There he took pleasure in botany and such geological investigation as the island afforded. He desired nothing more ardently than that nature should flourish around him, and his place was fragrant with myrtles, escalloniæ, and roses. He took much interest in a *Eucalyptus globulus*, which, planted close to the sea, grew to the height of twenty feet in a few years.

I do not recollect any one whose heart seemed as it were to go out to all living things with the warmth of affection shown by him. I cannot in this regard help recalling a circumstance which occurred in a walk with him on Langness. A bird's nest containing two eggs being found on the ground, he flung himself down beside it and contemplated it with the greatest delight, but without touching or disturbing it in the least.

He was an enemy to all the so-called "sports" in which cruelty to animals and gambling are the principal features, such as pigeon-shooting, horse-racing, &c. To one who asked him to subscribe 5*l.* for the establishment of a race-course his characteristic reply was: "I will gladly subscribe 5*l.* to prevent it." He even possessed a kind of sympathy, known only to poetic minds, for vegetable life, fully concurring with a remark I made to him, that a man who could take pleasure in felling a noble tree must be destitute of the finer feelings of humanity.

Mr Binney had a large, muscular frame, and his countenance in profile resembled that of Cato the censor, with whose character he had many points of strong resemblance.

Long time a sufferer in health without fatiguing his friends with complaints, "the silver cord was loosed" on December 8. The paralysis terminated fatally on the 19th, and on the 23rd he was buried in the family grave at Worksop.

He has left a widow, daughter of the Rev. David Jones, Rector of Hope Bagot, near Ludlow, and six children.

J. P. JOULE

THE LATE CHANGES IN THE VESUVIAN CONE

NOVEMBER, 1881.—The condition of the crater of Vesuvius is at present exceedingly interesting. This is especially so after the continuous active state that the mountain has been in for nearly three years. The old crater of 1872 is now completely filled, and has in fact been so for some time. About three-quarters of the edge

has been overflown by lava at various times, but especially by the eruptions of the last two years. Last June. arising from the plain or platform of lava formed by the filling of the crater, was the cone of eruption. This was situated east-north-east of the axis of the mountain. It formed a small steep-sided cone till the eruption of July destroyed the northern portion, forming a large low crater. Its condition on November 5, when I visited the crater or craters, was most instructive, and reminds one of a figure and description given by Sir W. Hamilton in his "Campi Phlegrei."

Arriving at the edge of the 1872 crater from the west one crosses the crater plain, and arrives at a low semi-circular ridge with an average height of about twenty feet. Ascending this rim-like heap of scoria, one observes occupying its irregular bottom fumaroles and yellow patches of decomposing lava. The complete crater of July is formed of this ridge, together with the southern portion of the former cone of eruption. Within this space rose another cone of eruption whose centre was occupied by the main vent. On this occasion it was possible to approach within a few yards of the great mouth, from which issued the column of vapour and momentary puffs of fluid lava fragments. Thus it will be seen that there are at present three cones and craters one within the other.

This, however, was not the most interesting point. In the lava of the great plain we discovered a large cone or lava tunnel about eight feet high, twenty or thirty feet long, and fifteen feet broad, but with a general slope downwards. The roof was composed of lava about eight months old, but much decomposed. The whole cave presented one glistening forest of stalactites, some three hundred about were counted; also stalagmites. Most of these were from two to three feet long, and a few twice that length; many, however, with a uniform diameter of less than an inch throughout and tubular, divided by septa, reminding one of an Orthoceras in structure. The colours most various and beautiful: bird's-egg blue, acqua marine, salmon white, yellow, and reddish brown, and many variegated in these colours. The effect after the eyes quitting the rugged and fierce scenes around seemed to rest on some fairy cave.

On attempting to approach the entrance the gust of hot air, redundant with hydrochloric acid vapour, almost prevented one from making an attempt at an entrance. However, these beautiful and interesting prizes determined me to make an endeavour. Nose and mouth muffled, and having placed my friends on each side of the entrance with a strap, I made a dive down some steps. The effect was at first almost suffocation, stinging of the conjunctiva, and a profuse perspiration. To grab a few of those stalactites near at hand and return was the work of a minute, then the hearty pull-up by my friends, a fit of coughing and a little fresh air restored me. This was repeated eight times, during which I was able to obtain all the best specimens, some thirty examples, and reach the extremity of the cavity. These prizes were carried carefully to Naples, where they have been placed under glass in a dry atmosphere, since they were highly deliquescent. A qualitative analysis gives the chief component as chloride of sodium, with chlorides of potassium, iron, manganese; sulphates of soda, potash, iron, and copper.

They were undoubtedly formed in the following manner:—The heavy rains we have had here lately dissolved out the materials from the decomposing lava above. The solution as it descended was evaporated by the current of hot air continually circulating through the cave, thus driving off the water and depositing the salt. Many showed within their cavities crystals of Halite Sylvine, and a few also Molysite.

December.—In the early part of this month lava commenced to flow down the eastern or Pompei side; this, although not seen from Naples, gave a brilliant reflection at night which could be observed from the city. This aurora continued with variable intensity until December 25, 1881, when it reached its climax. The lava had commenced to issue by a fissure nearly north of the base of the cone of eruption. During the three weeks that it flowed this fissure had become widened and opened up. On Christmas and the following day the quantity of lava increased much in quantity, and altogether Vesuvius was much more active. The rent at this time had extended down the slope about one-third the distance of the Vesuvian cone and formed at its upper or wider part, an opening of about 120 feet in breadth by the same in depth. The floor which I visited and walked up on December 29 was covered by the scoria and lava blocks continually falling from its edges. This floor sloped downwards to the end of the fissure at a small inclination. From its termination issued the larva already spoken of.

This was a good example of the opening up of a dyke to the surface of a volcanic cone, so lucidly described by Mallet ("Mechanism of Production of Volcanic Dykes, and on those of Mount Somma," *Quart. Journ. Geol. Soc.* vol. xxxii. p. 472).

The lava that issued at first descended the cone, crossed the Valle dell' Inferno, following the course of the 1834 stream, and threatening Otajano. It stopped, however, and followed a course across the Atrio in a north-east direction, where it can do no harm.

An important fact was brought out by this eruption, small as it was. When the level of the lava in the vent had been lowered by exclusion of the fissure downwards an entire change of ejectamenta took place. The soft masses of pasty lava as ejected generally was replaced by rounded fragments of solid and old lava and volcanic ashes. The cone of eruption having no longer the column of lava to support it internally had crumbled in and was being ejected piecemeal by the explosions in the form of stones and ash. This we had practical experience of. At one time approaching somewhat incautiously through the mist we were practically warned to beat a hasty retreat by hearing the rattle around us of small, and the heavy thud of larger stones. The beautiful yellow crater plane of 1872 had been covered by the dull grey ash, only relieved by numerous green-coloured saline crusts rich in copper. This was made evident on looking at our boot-soles, where we found the nails thickly plated with metallic copper.

Near the end of the above-mentioned fissure the lavas were flowing down the mountain in a tunnel. The roof had broken through at one place, and standing a few yards above this a fine sight presented itself. Figure a long fairly regular arched passage of about a metre and a half wide by the same in depth, along which one could see for one or two hundred yards.

This was bright red-hot, and flowing along its floor with considerable rapidity was a stream of bright orange-coloured lava with the liquidity almost of water. In this we were able to carry on some experiments on the specific gravity of molten and cold lava, which reverse the results obtained on former occasions by Palmieri and others, and which will prove that cold is of higher specific gravity than molten rock, as theoretically should be the case. These facts, however, will be described elsewhere.

H. J. JOHNSTON-LAVIS

ILLUSTRATIONS OF NEW OR RARE ANIMALS IN THE ZOOLOGICAL SOCIETY'S LIVING COLLECTION[1]

V.

11. THE Beatrix Antelope (*Oryx Beatrix*).—The antelopes of the genus Oryx constitute a well-defined and most beautiful group of the Bovine Family. Although not amongst the largest of the antelopes, they are animals of above the average size in the group. The males are

[1] Continued from vol. xxiv. p. 534.

furnished with very long straight or slightly recurved horns, which are also present, though not quite so highly developed, in the females. These organs are more or less ringed at the base, and are placed in a line with the anterior surface of the face, or nearly so. They constitute a formidable weapon of attack and defence, and on this account be-

Fig. 11.—The Beatrix Antelope.

come frequently broken in the case of captive specimens. The colour of the Oryxes is generally of a brilliant white, ornamented by black streaks, and occasionally clouded with shades of grey and rufous.

The best known member of the genus Oryx is the Leucoryx (*Oryx leucoryx*), a native of Senegal, but also met with in Sennaar and Nubia. Of this antelope, examples have been for many years in the Zoo-

Fig. 12.—The Thar.

logical Society's Menagerie, and have bred young ones on several occasions. Besides this species the Society's Collection contains at present several specimens of the still more beautiful Beisa Antelope (*Oryx beisa*), of Abyssinia. This antelope bred in the Society's Gardens last year, and the young animal has been figured in a re-

cent number of the *Proceedings* (see *Proc. Zool. Soc.*, 1881, p. 626, pl. liv.). Of the allied Gemsbuck of South Africa, well-known to the sportsmen of the Cape, though, according to Mr. Selous, now entirely confined to the arid deserts of the south-west, the Zoological Society have not, of late years at least, been able to exhibit living specimens. But the celebrated collection of the late Lord Derby formerly contained examples of both sexes, and the young, bred at Knowsley, is figured in the volume entitled "Gleanings from the Knowsley Menagerie."

To the three species above-mentioned of the genus *Oryx*, which have long been known to naturalists, a fourth was added some twenty years ago by the late Dr. Gray, who, in 1857, at one of the Zoological Society's meetings (see *Proc. Zool. Soc.*, 1857, p. 157, pl. lv.), described a new species based upon an animal received from Bombay, but supposed to have been originally brought from some part on the Red Sea. This species, as Dr. Gray pointed out, is in some respects intermediate between the Gemsbuck and the Leucoryx, having the straight horns of the former and the plain colour of the latter, but the dark legs and peculiar white feet at once separate it from both of them.

The Beatrix Antelope (*Oryx Beatrix*), as it was named by Dr. Gray after the Royal Princess of that name, although thus clearly defined, and excellently figured by Mr. Wolf, remained a somewhat obscure species until 1872, when, singularly enough, a second living example was received by Mr. Gwyn Jeffreys, F.R.S., from Colonel Pelly, H.B.M. Resident at Bushire, and deposited in the Society's collection. In 1878 a third example of the same antelope was received by the Society from Commander Burke, of the SS. *Arcot* This animal was obtained at Jedda, but was stated to have been originally captured in the Hedjez passes, some 150 miles in the interior of Arabia.

The fourth example of this antelope, lately presented to the Society by Lord Lilford, from which the present figure is taken (Fig. 11), comes from a still more definite locality. It was shipped to Lord Lilford by Lieut.-Col. S. B. Miles, British Consul at Muscat, with the information that it came from the great desert behind the mountainous district of Oman. It is now therefore abundantly evident from these four examples, which agree in all material points, that the Beatrix Antelope is a good and well-defined species, and that its native home is the interior of the Arabian peninsula, where it replaces the Beisa of the Abyssinian plateau.

12. The Thar (*Capra jemlaica*).—The peculiar Himalayan Goat, known to the Indian sportsmen as the Téhr, Thar, or Tahir, was first described in 1828 by Hamilton Smith, and named *Capra jemlaica*, from the district of Jemlah, to the north of Nepaul, in which his specimen was procured. It is found, however, as Dr. Jerden tells us, throughout "the whole extent of the Himalayas at great elevations, generally above the limits of forest and not far from the snow. It frequents rocky valleys and very steep and precipitous ground, and is often seen perched on what appear to be inaccessible crags. It feeds on the grassy spots among rocks, and though not unfrequently solitary, is more generally seen in flocks, sometimes as numerous as twenty, thirty, or even forty. If alarmed whilst feeding, these animals all go off at full speed with a clattering sound, but soon halt and turn to gaze on the intruder. They generally follow the guidance of an old male, and will make their way up almost perpendicular precipices if there be but a few rough edges or crevices. In the north they are said to be sometimes seen in company with the *Markkor* (*Capra megaceros*)."

The Thar also extends into Cashmere, and was found by Dr. A. Leith Adams to be common on the Pir Pinjal ranges, and still more so on the mountains on the banks of the Chenab, near Kistewar.

The first example of this wild goat received by the Zoological Society was obtained in 1852, and lived some years in the Menagerie (see Wolf and Sclater, *Zool. Sketches*, ser. i. t. xxv.). After the death of this animal the species remained unrepresented in the collection until 1880, when the examples now in the Gardens were presented to the Zoological Society by the Prince of Wales. His Royal Highness, on his return from India in 1876, brought home with him a pair of these animals, from which a young one was produced. The male unfortunately died at Sandringham, so that only the mother and young (also of the female sex) were transferred to the Society. Fig. 12 represents the adult female, in which the horns, although nearly of the same character as in the male, are not so large or so well developed.

FIG. 13.—The Indian Darter.

13. The Indian Darter (*Plotus melanogaster*).—The Darters form a very peculiar type of birds of the order Steganopodes, allied to the Cormorants in structure, but very Heron-like in gait and gesture. For several years the Zoological Society's fish-house has not failed to contain one or more specimens of these birds, which have given us abundant opportunities of observing their peculiar mode of fishing. The Darter in its normal position sits erect upon a branch or stump overlooking the water. When proceeding to fish it dives head foremost into the stream, and swimming entirely under water, transfixes its finny prey with the rapidity of lightning. Emerging from the water with the fish speared upon its long slender beak, the Darter chucks the fish into the air, and catching it head foremost with unerring aim, swallows it whole. This peculiar and interesting mode of fish-catching may be witnessed every day when the Darters in the Zoo-

logical Gardens are fed with their usual meal of small fishes.

The Darters usually exhibited in the Society's Gardens are of the South American species (*Plotus anhinga*), which, it seem, is the most easily obtained alive. But in 1878 an example of the African form Le Vaillant's Darter (*Plotus levaillanti*)[1] was received, and lived for some time in the Gardens, where it exhibited the characteristic mode of feeding previously observed in its American brother. In April last an example of a third species of this genus—the Indian Darter (*Plotus melangaster*) was obtained in exchange from the Zoological Gardens of Calcutta. After living for many months in excellent health this bird died suddenly on the 21st of December last, apparently from a sudden shock produced by feeding too rapidly.

In captivity the Indian Darter does not deviate as regards habits from the species previously received. "In a state of nature," as Dr. Jerden tells us, "this beautiful diver is found throughout all India, Ceylon, Burmah, and Malayana. It is exceedingly numerous in some parts of the country, especially in Bengal; hundreds are often to be seen on a single jheel. They hunt singly in general, or in scattered parties, but often roost in company, both at night and in the middle of the day, when numbers may be seen perched on the trees overhanging some tank or river. They float low on the water, often with nothing but the head and neck visible, and swim and dive with rapidity. After feeding for some time they perch on the bough of a tree or on a pole or stone, and spread their wings out to dry as the Cormorants do."

The Darters present some very abnormal features in the structure of the stomach and in the mechanism of the vertebræ of the neck. These have been elaborately described by the late Prof. Garrod from the specimens that have lived in the Society's Collection (*Proc. Zool. Soc.*, 1876, p. 335, and 1878, p. 679.

[1] The discovery recently made by Canon Tristram of the occurrence of this Darter breeding in large colonies on the Lake of Antioch is very remarkable, he species not having been previously known to occur north of Sennaar.

THE LICK OBSERVATORY

AN esteemed American correspondent has sent us the following information on this remarkable observatory:—

In December, 1874, Mr. James Lick determined to erect "the most powerful telescope in the world," somewhere within the boundaries of California, his adopted State. Various sites were proposed and considered, the first being Observatory Point on Lake Tahoe, which was soon abandoned on account of the severity of the winters at this place, and especially on account of the great snowfall. Mr. Lick's original idea was somewhat crude and unformed, but it took shape after consultation by letter and otherwise with various men of science in the East and elsewhere, and also with gentlemen of scientific tastes in California. Monte Diablo (3856 feet high), Mount Helena (4343 feet high), and other points, were successively proposed and, after examination, rejected. Finally, Mr. Lick sent Capt. Fraser, his man of business, to examine Mount Hamilton (4440 feet), an easily accessible peak some thirteen miles east of San José, in Santa Clara County. The first examination was made by Capt. Fraser, in August, 1875.

In most respects this site was found to be satisfactory, but the chief objections to it were found to be important, if not vital. The cost of constructing a road to the summit would certainly be very great, and the summit itself was a sharp point of very hard trap rock. To make a level space here for the reception of the necessary buildings would be a serious matter. Finally, no water was known anywhere near the summit. The last objection was disposed of by the discovery of two springs, only 4300 feet distant from the summit and 300 feet below it. Mr. Lick then announced that if Santa Clara County would build a suitable road connecting San José with the top of the mountain, he would establish and suitably endow an observatory on Mount Hamilton. After various changes in his plans Mr. Lick made a deed of trust (dated September 21, 1875), which gave a very large amount of real and personal property to five trustees to be by them expended for various purposes. The observatory was provided for as follows:—The trustees were authorised to expend the sum of 700,000 dollars for the purchase of the necessary land and for putting up on that land "a powerful telescope, superior to and more powerful than any telescope ever yet made," with the necessary machinery, &c, "and also a suitable observatory connected therewith." As soon as these objects are satisfactorily accomplished the observatory is to be turned over to the Regents of the University of California, to become a department of the University, and any surplus left over after paying for the land and observatory is to be invested in safe bonds. The income from these bonds is to be devoted to "the maintenance of the said telescope and of the observatory connected therewith, and shall be made useful in promoting science."

A grant of land was obtained from the United States; the proposition of Mr. Lick to Santa Clara county was accepted, and the road to the top of Mount Hamilton was built during 1876. It was formally accepted by the Trustees in January 1877. It is now maintained by Santa Clara county as a county road, and it is quite likely that it will soon be extended by Alameda county over the range into the San Joaquin valley. Probably no more magnificent mountain road exists in the United States, when one considers all the circumstances of fine surrounding scenery, excellent road-bed, and commanding views. Some idea of the engineering difficulties overcome can be had from the cost of constructing this highway twenty-six miles into the heart of the mountains, and with a rise of 4000 feet in twenty-two miles. Such a project would appal the average county surveyor of New England, but it was here accomplished at the large cost of 78,000 dols.

The maximum grade is 6 feet 6 inches in 100 feet, or about 343 feet in the mile. Most of the road, however, is materially less steep than this. The first four miles is a fine level avenue, laid out in a perfectly straight line in the Santa Clara valley. The ascent of the foothills is then commenced, and the road begins a series of turnings and twistings which are of course necessary to keep the gradient low. Toward the end of the route the road winds round and round the mountain itself and overlooks one of the most picturesque of scenes: the valley of Santa Clara and the coast range to the west, a bit of the Pacific to the south-west, the Sierra Nevadas with countless ranges between, to the south-east the San Joaquin valley, and the Sierras beyond to the east, while to the north on clear days you plainly see Mount Shasta (14,000 feet) 175 miles away. The bay of San Francisco lies open before you, like a child's dissecting map, and at the end of it Tamalpais, the mountain near the entrance to the Golden Gate.

Mount Hamilton has, properly speaking, three summits. The east peak is 4440 feet, the middle peak is 4350 feet, and the third, the observatory peak (originally 4256 feet), has been cut down to a level surface just large enough to contain the neeessary buildings for the instruments. The dwelling-house and workshops are on a narrow saddle some 50 feet below the summit. To gain the level surface some 29 feet of rock has been removed from the peak; in all about 40,000 tons. A level site is thus provided, and this is perfectly accessible from San José. With a light waggon one may trot the horses all the way. The springs have also been connected with "the hill," as it is called by the inhabitants, by a good

road along which a water-pipe is laid. These springs yield 850 gallons per day in the dryest time, and in the wet season as much as 5000 gallons per day. Thus a very serious problem is solved.

The decision of the general plans for the Observatory has fallen largely to the President of the Lick Trustees, Capt. R. S. Floyd. He has given to these questions an amount of time which few persons could possibly bestow on a matter outside of ordinary professional life. Since 1876 he has personally visited most of the observatories of Europe and America and has corresponded with astronomers all over the world. In 1879 he visited Washington, and together with Profs. Newcomb and Holden, of the Naval Observatory, he prepared a series of drawings from which the Observatory was to be built, and ordered the first of the instruments. The general plan of the Observatory is to give the place of honour to the large dome (some seventy-five feet in diameter). This is to contain a refracting telescope by Alvan Clark and Sons, of Cambridgeport, who have made not only the largest, but the best telescopes in the world. Their first telescopes were six inches in aperture and of exquisite definition. Without losing in precision, they have successively made object glasses of $8\frac{1}{4}$, $9\frac{1}{3}$, 12, $15\frac{1}{2}$, $18\frac{1}{2}$, 23, and 26 inches. They are now engaged on an objective of 30 inches for the Russian Government, and will soon commence the Lick telescope of 36 inches aperture, for which they have served so magnificent an apprenticeship. This is to occupy the whole of the south end of the plateau of the summit. At the northwest corner stands a dome (completed in November, 1881) which contains a 12-inch telescope by Alvan Clark, one of bis very finest. Connecting the two domes is to be a one-story building containing a clock room, workshops, a library, offices and bedrooms for observers. A transit house of iron (completed in 1881) stands a few feet east of the smaller dome, and just south of this is the photo-heliograph, with its house. A few feet east of this the six-inch meridian circle (by Repsold of Hamburg) is to stand, which, with the four-inch transit (by Fauth of Washington) completes the list of meridian instruments. A four-inch comet-seeker, by Clark, occupies a small dome. The main building will be built of brick. The bricks of clay, found close to the Observatory, are made under a contract which saves the Observatory some fifty per cent. of the usual cost. About 2,000,000 bricks are now made and ready to deliver, and these will just about suffice for the constructions agreed upon.

It will be seen that an observing station of importance is already established on the mountain, containing an equipment of which many European observatories would be proud. It may be said that the whole of the fund expended to date is less than the cost of the road to the summit, and this includes all expenses. This equipment has recently been utilised in the observation of the transit of Mercury on November 7, 1881, by Prof. Holden and Mr. Burnham, who were invited by the trustees to set up their first instruments. In 1879 Mr. Burnham spent three of the summer months on the mountain, and used his six-inch telescope in regular observations, the object being to compare the conditions of vision at this high altitude with those at lower levels. His conclusions were extremely favourable to the Mount Hamilton site, and from his report there is little doubt that during the summer months this site is more favourable than that of any observatory now established. During the winter, storms prevail, but the snow is not very deep, and does not lie long, and the temperature is not very low. When it is clear, in the rainy season, it is perfectly so, and the vision compares favourably with the average conditions at Eastern observatories. It is obvious that if the management of the Observatory affairs remains in the same able control, we shall have in a few years one of the most admirably equipped observatories in the world, on a site far superior to any; and without being too sanguine, it will be safe to expect much from such an institution in proper hands.

NOTES

Mr. MacLeod (Assistant Secretary, Education Department, Whitehall) having resigned, will be succeeded by Col. Donnelly, R.E., now Director of the Science Division, wbo, while retaining his present post, will, as Assistant Secretary of the Education Department, be the chief officer of the Science and Art Department at South Kensington.

The death is announced of Prof. Theodore Schwann of Liége, the eminent biologist, at the age of seventy-two years. We hope to refer to Prof. Schwann at length next week. We also learn of the death of Hermann Schlagintweit, well known as a naturalist, and in conjunction with his brother Emil, as an explorer of the Himalayas.

The death is announced of Signor Carlo Piaggia, who has done some good exploring work in the region to the south of Abyssinia. Signor Piaggia was proceeding from Khartoum to Fadassi to join Herr Shuver, to whose journey we referred last week.

We regret to learn that Mr. Joseph Thomson is daily expected home. It may be remembered that he was engaged for two years by the Sultan of Zanzibar to geologise along the Rovuma, and in other districts of the Sultan's dominions. We give elsewhere some of the results of his great excursion along the Rovuma, where he failed to find coal, which the Sultan was anxious he should do. We are informed that the Sultan is so disappointed at the result that he has abruptly broken the engagement, and sent Mr. Thomson home with payment only for the time he has been out. This is disappointing, as much good work would certainly have been done by Mr. Thomson had he been allowed to pursue his explorations. Evidently the Sultan has much to learn. We trust Mr. Thomson will soon find suitable employment for his exceptional ability as an explorer.

Some very important experiments have recently been carried out at the Conservatoire des Arts et Métiers, upon the accumulating power of Faure's secondary battery. A committee consisting of MM. Tresca, Potier, Joubert, and Allard conducted operations. Thirty-five accumulators of the spiral form, each set in a cylindrical stoneware pot about 35 centims. high and 25 centims. diameter, were charged in series by the current from a Siemens' dynamo-electric generator worked by a steam-engine. The working electromotive force of an accumulator was found to be from 2·15 to 2·5 volts. For twenty-two hours the battery was charged with a current whose average strength was 8·5 ampères, the total work expended in charging being 6,020,000 kilogrammetres. The total work of the steam-engine was also measured by a dynamometer, the Siemens' generator having, as it appeared, an efficiency of 71 per cent. The battery was then discharged through eleven Maxim lamps, the potential and current being accurately measured from time to time, and although the discharge lasted eleven hours there appeared to be 70 per cent. of the original energy given out in the discharge. A complete report is promised by the committee.

The umbrella trade (according to the *Scientific American*) threatens the existence of the pimento (pepper) plantations of Jamaica. It was shown by an official estimate made at Kingston last autumn, that more than half a million umbrella sticks were then awaiting export to England and the United States. These sticks were almost without exception pimento, and it is not surprising that owners and lessees of pimento walks are becoming alarmed at the growth of a trade which threatens to uproot, in a

few years, all the young trees. The export returns for the last five years show an average of 2000 bundles of sticks sent out from Jamaica annually, and the returns for the first three-quarters of 1881 show an export of over 4500 bundles, valued at 15,000 dollars. Each bundle contains from 500 to 800 sticks, each of which represents a young bearing pimento tree.

THE results of a third year's observation of spirit-levels at Secheron, for elucidation of periodic movements of the ground, are given by M. Plantamour in the December issue of *Archive des Sciences*, and Col. von Orff also communicates results obtained at the Observatory o Bogenhausen (3 to 4 km. from Munich). M. Plantamour shows that the oscillations, both in the east-west and the north-south direction, present anomalies, or differences from year to year, which cannot be explained by mere variations of the temperature of the air. The earth's surface he supposes to be in a state of constant gentle undulation, the direction and amplitude of which varies in each locality according to the nature of the ground and the forces in action; and the effect may strengthen, or neutralise that of the air temperature on the ground, or even produce a movement in an opposite direction. Col. von Orff's observations afford ground for supposing that the spirit-level variations are, partly at least, caused by variations of heat in the formation on which the Observatory rests.

"RHOPALOCERA MALAYANA: a Description of the Butterflies of the Malay Peninsula," is the title of a work which will shortly be published by Mr. W. L. Distant. It is proposed in this work to give a monographic revision and synonymic catalogue of the butterflies of the Malay Peninsula, including the islands of Penang and Singapore. The fauna of the western side of the Peninsula is at present best known, and will be here principally treated. This area will extend from Quedah to Johore, and thus comprises the Straits Settlements of Province Wellesley, Perak, and Malacca. Each species (and variety where considered necessary) will be represented by a coloured figure, and the details of its habits, variation, and geographical distribution will be given as far as our present knowledge will allow. An introduction to the classification will also be added, with a tabular arrangement of the genera. The Malayan butterfly fauna is very rich in species, and very typical of the Oriental region. It includes numbers of species which are found in Continental India, and many others which are common to Sumatra, Java, and Borneo. It is therefore anticipated that the work may prove useful to others than Malayan entomologists alone. It is to the scientific enterprise of Mr. D. Logan of Penang that the inception of this work is due, and an important part of the material on which it is based will be derived from that gentleman's collectors, who have been despatched to Quedah, Malacca, and Johore. Beside the collections made by the author, when in Penang and Province Wellesley, many others have been examined, and much information acquired, during the last ten years. The work will be comprised in six or seven royal quarto parts, each containing four coloured plates, and about twenty-eight pages of letterpress.

CONTINUING his researches on the Hydroids and Medusæ of the White Sea, and giving a *résumé* of his three years' exploration in Solovetzky Bay, Prof. Wagner states that ten different species of Medusæ inhabit the waters of this lake: *Lizzia rota*, *Bougainvillia superciliaris*, *Circe kamtschatica*, *Sarsia tubulosa*, *Plankayon hyalinus* (n. sp. et g.), *Ægionopsis Laurentii*, *Tiara pileata*, *Staurophora laciniata*, *Cyanea Arctica*, and *Aurelia aurita*. Each of these forms show some special adaptation to the medium they live in. The two first are the simplest, the primary ones, so to say, and their most important feature is the great development of the generative organs. The elegant form of the bell of the *Circe* is adapted to a rapid and ingenious motion, and its long tentacles are perfectly developed for warning it against any danger. The voracious *Sarsia* is adapted for continually searching for and catching prey at different depths, by means of its very long tentacles. The *Tiara* is characterised by a perfect development of its great stomach and mouth-ciliæ, and the large vessels are adapted for the circulation of a great amount of nutritive liquids. The *Ægionopsis* is distinguished by its large bell, which affords great room for the sexual sinuses of the stomach, whilst four tentacles inclosing the bell are protective of this great sexual laboratory. The *Staurophora* has the same characters, with some modifications for the enlargement of the nutritive and sexual organs. The flat and flexible bell of the *Cyanea* is an immense nutritive organ, to which large tentacles and a great catching-bag supply plenty of food. And the *Aurelia* is, so to say, a *résumé* of all these adaptations. Altogether they afford a fine illustration of the Etienne Geoffroy St. Hilaire's law of "organic equilibrium, or compensation of organs." All are equally well-armed for the struggle for existence and for the life in common in the waters of the White Sea. If the lazy and badly-armed *Lizzia* and *Bougainvillia* are often subject to starvation, a few individuals on the other hand suffice for producing millions of progeny. Prof. Wagner also makes some interesting remarks with regard to Milne Edwards's law as to the tendency of Nature towards diversity and economy of means.

WE have repeatedly had occasion to refer to the excellent work now in course of publication—"Anatomisch-physiologischer Atlas der Botanik," by Dr. Arnold Dodel Port, of Zürich University, and have pleasure in announcing that the 5th part of this remarkable work has just left the press. It is a specially interesting one, and contains the following subjects:—(1) *Marchantia polymorpha*, a cosmopolitan liverwort-moss, with its characteristic fruit receptacles and sporanges, of which the whole development is illustrated; (2) *Taxus baccata*, yew, with the simplest possible female flower, showing the anatomy of the ripe seed and the first germination stages of the latter; (3) *Oedogonium diplandrum Juranyi*, one of the oospore-forming filamentous Algæ, showing the green asexual zoospores, the yellowish androspores, the yellow spermatozoids, and the dwarfed males. The whole process of fertilisation and the development of oospores is also represented, this being one of the most interesting Oedogonieæ; (4) *Chara fragilis*, showing the rotation of the cell contents in the tubular cells and the female organs; (5) *Cydonia vulgaris*, Quince, showing the development of the flower and its fertilisation by the honey-bee; (6) *Centaurea cyanus*, Blue Cornflower, with the development of the protandrous flowers, showing the sensitiveness and functions of the contractile stamens facilitating the fertilisation by insects carrying pollen from other flowers. The author hopes to publish Part 6 early in April next, and Part 7 in the autumn, thus completing the work.

THE Danish Society for the Protection of Animals (under the patronage of His Majesty the King of Denmark) offers two prizes, of 2000 and 1000 francs respectively, for the best and second best scientific essay on that part of the Vivisection question, which concerns the possibility of replacing *living* by *recently killed animals* for the sake of physiological investigations. The essay should sufficiently indicate previously unknown cases, in which such a substitution of dead material may be applicable. In these essays the possibility and desirability of replacing painful experiments on animals by some *other methods of research*, may also be a subject of inquiry. The essays may be written in the Danish, Swedish, English, French, or German languages, and forwarded before September 1, 1882, to His Excellency Mr. A. de Haxthausen, President of the Danish Society for the Protection of Animals, at the office of the Society, Copenhagen. "Our Society is only too well aware that the claims of humanity are not to be satisfied by these means, as extensively as it could wish. It will however feel itself richly rewarded, if its efforts

result in diminishing the number of experiments in which animals are subjected to great and lingering agony. In this earnest hope we respectfully request all humanely disposed scientific men of every country in the world, kindly to comply with our invitation."

THE Russian representative at Peking is said to be urging on the Chinese Government the construction of a line of telegraph across Mongolia, to connect the Shanghai line with the Russian land-lines of Siberia. Should this line be carried out Peking will be in telegraphic communication by two separate routes with Europe; but it is said that the Chinese do not view the project with very favourable eyes. The new Chinese telegraphs seem to be doing their work very well. The people living along the route have abandoned their hostility, which has given way before feelings of wonder and admiration. The common people call the telegraphs "letter-poles," and think that the letters are despatched through the wires, which are believed to be hollow.

THE popular belief that the present Japanese are iconoclastic in their zeal for removing the ancient monuments of the country would seem to be a mistake. We read in the *Japan Gazette* that a society, composed of the Prime Minister, the Assistant Prime Minister, and other high officials and nobles, has just been formed for the protection of old temples, shrines, and other remnants of antiquity. A sum of two millions of *yen*, or about 400,000*l.* sterling, has been collected, and it is intended to devote the interest of this amount to the purposes of the Association. Not long since we read of a large collection—the present Minister for Foreign Affairs being among the principal subscribers—being made for the maintenance and repair of the Temple of Hachiman, or the Genius of War, at Kamakura, which contains many ancient and interesting relics. Indeed the work of destruction seems to have been confined to feudal castles, fortifications, &c. The former residences, or *yashikis*, of the nobles have been dismantled and converted into schools, hospitals, barracks, public offices, &c. Many picturesque structures throughout the country have thus been removed; but the Government deemed this absolutely necessary in order to eradicate feudal feeling, as well as to destroy strongholds for possible malcontents. The beautiful temples and shrines of old Japan still remain, and are, we see, to be maintained unimpaired.

THE Chinese authorities of Shanghai recently issued a quaint decree respecting the neglect of physicians to attend at once on their patients, and the high fees which they charge. They give notice that it is the duty of all physicians to use their knowledge for the benefit of the people; when people are sick they must be ready to attend upon them whenever they are sent for, without regarding the hour of the night or day, or the state of the weather. When people are ill they long for the presence of the doctor as the grain of seed longs for the rains. Instead of doing this, however, the physicians now think that they possess great skill, and not only charge high fees, but insist on being paid full hire for their chair coolies, and they do not care what becomes of the patient so that they get their fees. If these were only charged to the wealthy it would not so much matter; but the poor have to pay them also. An evil practice (the decree goes on) also exists by which doctors will not visit their patients before one o'clock in the afternoon; some will even smoke opium and drink tea until late in the evening. These are abuses, the magistrates say, which they will on no account permit. Doctors must attend their patients at all times; they must, if necessary, visit them several times daily; they must think more of them and less of their fees. Notice, therefore, is given to all officials and people that a physician who does not attend when he is called must only receive half his fees and half his chair hire. "If you physicians delay your visits you show your wickedness, and sin against yourselves." The decree is a model one for a paternal government; argument, entreaty, objurgation, exposition, threats, are all mingled in due proportions.

WHILST smaller glaciers leave only shallow grooves and scratches on the surface of the rocks, it is easy to see that the mighty glaciers of the Glacial period must have covered all the surface of the wide track they moved upon with deeper grooves and with low elongated ridges. Finland displays at every step an illustration of this activity of glaciers, which one of the Russian explorers of that country has described as a "telescopic glacier-scratching." Now, M. Koudravtseff, the geologist of the Russian White Sea Expedition, gives, in the *Proceedings* of the St. Petersburg Society of Naturalists, a description of the same phenomenon on the Kola Peninsula and on the west coast of the White Sea. All these scratches, troughs, and elongated embossments have the direction from west to east, showing thus that in the neighbourhoods of the White Sea the great Scandinavian and Finnish ice-covering moved towards the east.

MR. PENGELLY, F.R.S., was presented with an admirable portrait of himself at Torquay on Thursday last, as a mark of the admiration, respect, and regard in which he is held by his fellow-townsmen and friends elsewhere.

PROF. ALBERT GAUDRY, the eminent palæontologist, has been elected to the place in the Paris Academy of Sciences rendered vacant by the death of the late M. H. Sainte-Claire Deville.

THE Commission appointed by the French Chamber of Deputies to deliberate on the sale of the jewels of the French Crown has interrogated the Professor of Mineralogy of the Museum, requesting him to mark those stones which it would be desirable to send to the collection of that establishment.

SIR ERASMUS WILSON has presented a sum of ten thousand pounds to found and endow a chair of Pathological Anatomy in Aberdeen, "as an expression of my regard for an institution in which my father, a native of Aberdeen, received his medical education, and as a recognition of the honour which the University has been pleased to confer on me by granting me the distinguished degree of LL.D."

THE Etna Observatory, erected on a small mount near the crater, and so placed that a current of lava would probably divide in two and avoid it, has been completed. It is 2943 metres above the sea; the Great St. Bernard Monastery is 2491, and the St. Gothard 2075 metres.

THE Thirty-fifth Annual General Meeting of the Institution of Mechanical Engineers will be held to-day and to-morrow, at 25, Great George Street, Westminster. The chair will be taken by the President at half-past seven p.m. each evening. The following papers will be read and discussed:—On meters for registering small flows of water, by Mr. J. J. Tylor, of London; on the Bazin system of dredging, by Mr. A. A. Langley, of London; on hydraulic lifts for passengers and goods, by Mr. Edward Bayzand Ellington, of London; on improved appliances for working under water, or in irrespirable gases, by Mr. W. A. Gorman, of London; on power hammers with a movable fulcrum, by Mr. Daniel Longworth, of London.

FROM the Prospectus of Lectures and Classes for the second term of the present session of University College, Nottingham, we are pleased to see that the institution is in full working order. Both day and evening classes and lectures are well provided for, science occupying a prominent place.

THREE out of the eight articles in the new number of the *Quarterly Review* are scientific:—An article on Sir Charles Lyell, *à propos* of his recently published Life and Letters;

another on Mr. Darwin's work on Earthworms; and a third on Dr. Günther's work on Fishes.

THE Austrian naturalist, Dr. Karl Helmes, has discovered a new viper in a valley of the Makattan Mountains in Central Egypt. He has named it *Ammodytes-ægyptiaca Helmesii.* It has nothing in common with *Cerastes cornutus*, the yellow horned viper. The principal difference is that the horn-points are not above the eyes but about 4 mm. behind them. The animal does not hiss like other serpents, but makes a rattling noise as when water is thrown upon red-hot iron. The discovery will be all the more interesting to zoologists as this is the first new species discovered for many years.

THE Budget Commission of the German Reichstag has again granted 75,000 marks (3750*l.*) for the investigation of Central Africa. The Berlin African Society intends to send out two expeditions during 1882, one to start from the west and another from the south-west. It is further expected that the German station at Hakoma (Lake Tanganyika) will soon be able to pay its own expenses by establishing plantations and opening commercial relations with the neighbouring tribes.

THE Academy of Meteorological Aërostation of France has sent to M. Paul Bert a report which was adopted at its last session, and which suggests that an international exhibition of "Aërial arts" should be held in Paris in 1883, to commemorate the invention of balloons by the two Montgolfiers in 1783. The first public experiment having taken place at Annonay on June 5, 1783, a local commemoration is to take place in that town. The "Aërial arts" are to include every industry, science or art, relating to gas or the atmosphere, which is supposed to have any connection directly or indirectly with aërostatic experiments.

A SUBMARINE eruption took place recently in the Gulf of Missolonghi, not far from Anatolikon. For five days a strong odour of sulphuretted hydrogen was noticed in the neighbourhood, and whole ships' cargoes of dead fish were washed ashore.

A SMART shock of earthquake occurred at Iquique on November 13, and the master of the German barque *Shakespeare*, from Liverpool, reports that he felt it when about eight miles to the westward of Punta Arenas with such severity that he imagined the vessel had struck on a rock until the lead showed that he was in deep water. On Saturday night an earthquake shock was felt at Agram, lasting three seconds, and accompanied by a rumbling noise. Intelligence reached Plymouth on Monday from Yokohama of a destructive earthquake in China. The news, which was despatched from Yokohama on December 25, coming by way of San Francisco and New York, is exceedingly meagre. It simply announces the fact that a severe earthquake had occurred in the district of "Kantcheou," and that more than 250 people had been killed.

THE additions to the Zoological Society's Gardens during the past week include a Markhoor (*Capra megaceros* ♀) from Afghanistan, presented by Lieut.-Col. St. John; a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, presented by Miss Morson; a Common Raven (*Corvus corax*), British, presented by Mr. S. J. Elyard; a Spanish Terrapin (*Clemmys leprosa*), South European, presented by Mr. H. Balfour; a collection of Sea Anemones, British Seas, presented by Mr. A. D. Bartlett; a Malayan Bear (*Ursus malayanus*) from Malacca, purchased; a Cashmere Shawl Goat (*Capra hircus*, var.), born in the Gardens.

GEOGRAPHICAL NOTES

AT the meeting of the Geographical Society last week, Sir John Kirk read a paper by Mr. Joseph Thomson, on his examination of the Rovuma basin, East Africa, during his recent trip in search of the long-talked of coal-beds. These were supposed to be situated at the Mavitu village of Itule on the banks of the Lujende, some three days' march from its confluence with the Rovuma, but on investigation proved to be only some irregular layers of bituminous shale, which are of no practical use. Though disappointed in the primary object of his journey, Mr. Thomson has been able to add much to our knowledge of the geography of the Rovuma region, having traversed between 600 and 700 miles of country, besides furnishing many interesting particulars respecting the seven tribes, or remnants of tribes, which are found there. A paper by the Rev. Channey Maples, of the Universities' Mission, was afterwards read, on Makua Land between the Rivers Rovuma and Luli, a tract of country hitherto entirely unknown. Mr. Maples had hoped to have gone right through from Masasi to Mozambique, but on his arrival at Mvalixa's, the capital of the Meto Makuas, he was unable to induce his followers to proceed further. He had, therefore, to abandon his projected visit to the fierce branch of the Makua tribe, called the Walomwe; but what was more annoying, his hopes of verifying the existence of a snowy mountain, named Irati by the natives, and said to be about half way between Meto and Mozambique. In the discussion which fol- followed the reading of these papers, Sir John Kirk made some interesting remarks on the great expansion of the india-rubber trade in East Africa during recent years, the value of the annual export having risen from *nil* to about a quarter of a million sterling.

AFTER his recent discovery of the source of the River Lujende in what he supposes to be the unexplored northern portion of Lake Shirwa, the Rev. W. P. Johnson, of the Universities' Mission, followed the course of the river with a view to returning to his station at Mataka's town, but he was met outside and informed by the chief that his house had been utterly wrecked and his very books torn to pieces and scattered to the four winds of heaven. The outrage appears to have been committed by the owners of a slave-caravan, who believed that Mr. Johnson had contrived to send down information which had enabled Capt. Foot, R.N., to stop them some fifteen miles from the coast. Mr. Johnson had consequently been obliged to go to Zanzibar to refit, and as it would be impossible to settle again at his old station for the present, he intends to establish himself at Losewa, on the eastern shore of Lake Nyassa, in about S. lat. 13°. Thence he hopes to work Mataka's town, and he ought to be able to obtain useful information about this almost unknown side of the lake.

A TELEGRAM from St. Petersburg states that a scientific expedition, consisting of members of the Russian Geographical Society, the Imperial Academy of Sciences, and others, is being equipped for the purpose of making historical and ethnographical researches in Bulgaria and Roumelia. Prince Alexander of Bulgaria has contributed 4000*l.* towards the expenses of the expedition, in the work of which it is hoped Prince Vogorides will join.

MR. CUTHBERT PEEK is to read a paper on his journey in Iceland last summer, at the Geographical Society's meeting on January 30.

MR. BARHAM, an experienced surveyor, is to start this week for West Africa, for the purpose, it is said, of surveying a line for a light railway from the Gold Coast littoral through the little-known gold-mining region of Wassaw, which will pass the property of several mining companies. The country which will be opened up by this railway, if it be constructed, is rich in palm-oil, india-rubber, &c., in addition to the precious metal.

THE first number of *Petermann's Mittheilungen* for this year contains a letter from Mr. Schuver, giving details of his journey on the Upper Nile, to which we have already referred. There is a good summary of the Arctic work of the year, with special reference to Wrangel Land, of which island an excellent map is given from recent surveys. An interesting sketch is given of convict life in Siberia, and a summary of recent work in the Congo basin. A brief but valuable sketch of the Karachis of the Caucasus, followed by the monthly notes, concludes the number. A valuable geological map of West Africa, after data furnished by Dr. Lenz, accompanies the number.

THE new part (Heft i. band iii.) of the *Mittheilungen* of the German African Society contains several communications. Dr. Buchner has reached Loanda on his return journey. There is a series of interesting letters from the members of the German

station at Kakoma, in 32° 29′ E., and 5° 47′ S., in the plateau which begins at the boundary of Ugogo with the Mpwapa heights. The letters contain a good deal of information on the country and the people, the fauna, flora, and climate. Dr. Stecker gives an account of his Abyssinian journey, to which we have already referred. Herr Flegel gives a long account of his journey from Rubba, on the Niger, north to Sokoto and back, between October 1880 and April 1881. His map contains much new and useful information on the country traversed. Finally there are some letters from Herren Pogge and Wissmann, who had reached Malange in May, and hoped to be at Kimbundo in June.

FURTHER RESEARCHES ON ANIMALS CONTAINING CHLOROPHYLL[1]

IT is now nearly forty years since the presence of chlorophyll in certain species of Planarian worms was recognised by Schultze. Later observers concluded that the green colour of certain infusorians, of the common fresh-water hydra, and of the fresh water sponge was due to the same pigment, but little more attention was paid to the subject until 1870, when Ray Lankester applied the spectroscope to its investigation. He thus considerably extended the list of chlorophyll-containing animals, and his results are summarised in Sachs' Botany (Eng. ed.). His list includes, besides the animals already mentioned, two species of Radiolarians, the common green sea anemone (*Anthea cereus*, var. *smaragdina*), the remarkable Gephyrean, *Bonellia viridis*, a Polychæte worm, *Chætopterus*, and even a Crustacean, *Idotea viridis*.

The main interest of the question of course lies in its bearing on the long-disputed relations between plants and animals; for, since neither locomotion nor irritability are peculiar to animals, since many insectivorous plants habitually digest solid food, since cellulose, that most characteristic of vegetable products, is practically identical with the tunicin of Ascidians, it becomes of the greatest interest to know whether the chlorophyll of animals preserves its ordinary vegetable function of effecting or aiding the decomposition of carbonic anhydride and the synthetic production of starch. For although it had long been known that *Euglena* evolved oxygen in sunlight, the animal nature of such an organism was merely thereby rendered more doubtful than ever. In 1878 I had the good fortune to find at Roscoff the material for the solution of the problem in the grass-green planarian, *Convoluta Schultzii*, of which multitudes are to be found in certain localities on the coast, lying on the sand, covered only by an inch or two of water, and apparently basking in the sun. It was only necessary to expose a quantity of these animals to direct sunlight to observe the rapid evolution of bubbles of gas, which, when collected and analysed, yielded from 45 to 55 per cent. of oxygen. Both chemical and histological observations showed the abundant presence of starch in the green cells, and thus these planarians, and presumably also *Hydra*, *Spongilla*, &c., were proved to be truly "vegetating animals."

Being at Naples early in the spring of 1879, I exposed to sunlight some of the reputedly chlorophyll-containing animals to be obtained there, namely, *Bonellia viridis* and *Idotea viridis*, while Krukenberg had meanwhile been making the same experiment with *Bonellia* and *Anthea* at Trieste. Our results were totally negative, but so far as *Bonellia* was concerned this was not to be wondered at, since the later spectroscopic investigations of Sorby and Schenk had fully confirmed the opinion of Lacaze-Duthiers as to the complete distinctness of its pigment from chlorophyll. Krukenberg, too, who follows these investigators in terming it *bonellein*, has recently figured the spectra of Anthea-green, and this also seems to differ considerably from chlorophyll, while I am strongly of the opinion that the pigment of the green crustaceans is, if possible, even more distinct, having not improbably a merely protective resemblance.

It is now necessary to pass to the discussion of a widely distinct subject—the long-outstanding enigma of the nature and functions of the "yellow cells" of Radiolarians. These bodies were first so called by Huxley in his description of *Thallassicolla*, and are small bodies of distinctly cellular nature, with a cell wall, well-defined nucleus, and protoplasmic contents saturated by a yellow pigment. They multiply rapidly by transverse division, and are present in almost all Radiolarians, but in very variable number. Johannes Muller at first supposed them to be concerned with reproduction, but afterwards gave up this view. In his famous monograph of the Radiolarians, Haeckel suggests that they are probably secreting-cells or digestive glands in the simplest form, and compares them to the liver-cells of Amphioxus, and the "liver-cells" described by Vogt in *Velella* and *Porpita*. Later he made the remarkable discovery that starch was present in notable quantity in these yellow cells, and considered this as confirming his view that these cells were in some way related to the function of nutrition. In 1871 a very remarkable contribution to our knowledge of the Radiolarians was published by Cienkowski, who strongly expressed the opinion that these yellow cells were parasitic algæ, pointing out that our only evidence of their Radiolarian nature was furnished by their constant occurrence in most members of the group. He showed that they were capable not only of surviving the death of the Radiolarian, but even of multiplying, and of passing through an encysted and an amœboid state, and urged their mode of development and the great variability of their numbers within the same species as further evidence of his view.

The next important work was that of Richard Hertwig, who inclined to think that these cells sometimes developed from the protoplasm of the Radiolarian, and failing to verify the observations of Cienkowski, maintained the opinion of Haeckel that the yellow cells "fur den Stoffwechsel der Radiolarien von Bedeutung sind." In a later publication (1879) he, however, hesitates to decide as to the nature of the yellow cells, but suggests two considerations as favouring the view of their parasitic nature—first, that yellow cells are to be found in Radiolarians which possess only a single nucleus, and secondly, that they are absent in a good many species altogether.

A later investigator, Dr. Brandt of Berlin, although failing to confirm Haeckel's observations as to the presence of starch, has completely corroborated the main discovery of Cienkowski, since he finds the yellow cells to survive for no less than two months after the death of the Radiolarian, and even to continue to live in the gelatinous investment from which the protoplasm had long departed in the form of swarm-spores. He sums up the evidence strongly in favour of their parasitic nature.

Meanwhile similar bodies were being described by the investigators of other groups. Haeckel had already compared the yellow yells of Radiolarians to the so-called liver-cells of *Velella*; but the brothers Hertwig first recalled attention to the subject in 1879 by expressing their opinion that the well-known "pigment bodies" which occur in the endoderm cells of the tentacles of many sea-anemones were also parasitic algæ. This opinion was founded on their occasional occurrence outside the body of the anemone, on their irregular distribution in various species, and on their resemblance to the yellow cells of Radiolarians. But they did not succeed in demonstrating the presence of starch, cellulose, or chlorophyll. The last of this long series of researches is that of Hamann (1881), who investigates the similar structures which occur in the oral region of the Rhizostome jelly-fishes. While agreeing with Cienkowski as to the parasitic nature of the yellow cells of Radiolarians, he holds strongly that those of anemones and jelly-fishes are unicellular glands.

In the hope of clearing up these contradictions, I returned to Naples in October last, and first convinced myself of the accuracy of the observations of Cienkowski and Brandt as to the survival of the yellow cells in the bodies of dead Radiolarians, and their assumption of the encysted and the amœboid states. Their mode of division, too, is thoroughly algoid. One finds, not unfrequently, groups of three and four closely resembling *Protococcus*. Starch is invariably present; the wall is true plant-cellulose, yielding a magnificent blue with iodine and sulphuric acid, and the yellow colouring-matter is identical with that of diatoms, and yields the same greenish residue after treatment with alcohol. So, too, in Velella, in sea-anemones, and in medusæ; in all cases the protoplasm and nucleus, the cellulose, starch, and chlorophyll, can be made out in the most perfectly distinct way. The failure of former observers with these reactions, in which I at first also shared, has been simply due to neglect of the ordinary botanical precautions. Such reactions will not succeed until the animal tissue has been treated with alcohol and macerated for some hours in a weak solution of caustic potash. Then, after neutralising the alkali by means of dilute acetic acid, and adding a weak solution of iodine, followed by strong sulphuric acid, the

[1] Abstract of a paper "On the Nature and Functions of the 'Yellow Cells' of Radiolarians and Cœlenterates," read to the Royal Society of Edinburgh on January 14, 1882, and published by permission of the Council.

presence of starch and cellulose can be successively demonstrated. Thus, then, the chemical composition, as well as the structure and mode of division of these yellow cells, are those of unicellular algæ, and I accordingly propose the generic name of *Philozoon*, and distinguish four species, differing slightly in size, colour, mode of division, behaviour with reagents, &c., for which the name of *P. radiolarum*, *P. siphonophorum*, *P. actiniarum*, and *P. medusarum*, according to their habitat, may be conveniently adopted. It now remains to inquire what is their mode of life, and what their function.

I next exposed a quantity of Radiolarians (chiefly *Collozoum*) to sunshine, and was delighted to find them soon studded with tiny gas-bubbles. Though it was not possible to obtain enough for a quantitative analysis, I was able to satisfy myself that the gas was not absorbed by caustic potash, but was partly taken up by pyrogallic acid, that is to say, that little or no carbonic acid was present, but that a fair amount of oxygen was present, diluted of course by nitrogen. The exposure of a shoal of the beautiful blue pelagic Siphonophore, *Velella*, for a few hours, enabled me to collect a large quantity of gas, which yielded from 24 to 25 per cent. of oxygen, that subsequently squeezed out from the interior of the chambered cartilaginous float, giving only 5 per cent. But the most startling result was obtained by the exposure of the common *Anthea cereus*, which yielded great quantities of gas containing on an average from 32 to 38 per per cent. of oxygen.

At first sight it might seem impossible to reconcile this copious evolution of oxygen with the completely negative results obtained from the same animal by so careful an experimenter as Krukenberg, yet the difficulty is more apparent than real. After considerable difficulty I was able to obtain a large and beautiful specimen of *Anthea cereus*, var. *smaragdina*, which is a far more beautiful green than that with which I had been before operating—the dingy brownish-olive variety, *plumosa*. The former owes its colour to a green pigment diffused chiefly through the ectoderm, but has comparatively few algæ in its endoderm; while in the latter the pigment is present in much smaller quantity: but the endoderm cells are crowded by algæ. An ordinary specimen of *plumosa* was also taken, and the two were placed in similar vessels side by side, and exposed to full sunshine, by afternoon the specimen of *plumosa* had yielded gas enough for an analysis, while the larger and finer *smaragdina* had scarcely produced a bubble. Two varieties of *Ceriactis aurantiaca*, one with, the other without, yellow cells, were next exposed, with a precisely similar result. The complete dependence of the evolution of oxygen upon the presence of algæ, and its complete independence of the pigment proper to the animal was still farther demonstrated by exposing as many as possible of those anemones known to contain yellow cells (*Aiptasia chamæleon*, *Helianthus troglodytes*, &c.) side by side with a large number of forms from which these are absent (*Actinia mesembryanthemum*, *Sagastia parasitica*, *Cerianthus*, &c.). The former never failed to yield abundant gas rich in oxygen, while in the latter series not a single bubble ever appeared.

Thus, then, the colouring matter described as chlorophyll by Lankester has really been mainly derived from that of the endodermal algæ of the variety *plumosa*, which predominates at Naples; while the Anthea-green of Krukenberg must mainly consist of the green pigment of the ectoderm, since the Trieste variety evidently does not contain algæ in any great quantity. But since the Naples variety contains a certain amount of ordinary green pigment, and since the Trieste variety is tolerably sure to contain some algæ, both spectroscopists have been operating on a mixture of two wholly distinct pigments—diatom-yellow and anthea-green.

But what is the physiological relationship of the plants and animal thus so curiously and intimately associated? Every one knows that all the colourless cells of a plant share the starch formed by the green cells; and it seems impossible to doubt that the endoderm cell or the Radiolarian, which actually incloses the vegetable cell, must similarly profit by its labours. In other words, when the vegetable cell dissolves its own starch, some must needs pass out by osmose into the surrounding animal cell; nor must it be forgotten that the latter possesses abundance of amylolytic ferment. Then, too, the *Philozoon* is subservient in another way to the nutritive function of the animal, for after its short life it dies and is digested; the yellow bodies supposed by various observers to be developing cells being nothing but dead algæ in progress of solution and disappearance.

Again, the animal cell is constantly producing carbonic acid and nitrogenous waste, but these are the first necessities of life to our alga, which removes them, so performing an intracellular renal function, and of course reaping an abundant reward, as its rapid rate of multiplication shows.

Nor do the services of the *Philozoon* end here; for during sunlight it is constantly evolving nascent oxygen directly into the surrounding animal protoplasm, and thus we have actually foreign chlorophyll performing the respiratory function of native hæmoglobin! And the resemblance becomes closer when we bear in mind that hæmoglobin sometimes lies as a stationary deposit in certain tissues, like the tongue muscles of certain molluscs, or the nerve cord of *Aphrodite* and Nemerteans.

The importance of this respiratory function is best seen by comparing as specimens the common red and white Gorgonia, which are usually considered as being mere varieties of the same species, *G. verrucosa*. The red variety is absolutely free from *Philozoon*, which could not exist in such deeply-coloured light, while the white variety, which I am inclined to think is usually the larger and better grown of the two, is perfectly crammed. Just as with the anemones above referred to, the red variety evolves no oxygen in sunlight, while the white yields an abundance, and we have thus two widely contrasted *physiological varieties*, as I may call them, without the least morphological difference The white specimen, placed in spirit, yields a strong solution of chlorophyll: the red, again, yields a red solution, which was at once recognised as being tetronerythrin by my friend M. Merejkowsky, who was at the same time investigating the distribution and properties of that remarkable pigment, so widely distributed in the animal kingdom. This substance, which was first discovered in the red spots which decorate the heads of certain birds, has recently been shown by Krukenberg to be one of the most important of the colouring matter of sponges, while Merejkowsky now finds it in fishes and in almost all classes of invertebrate animals. It has been strongly suspected to be an oxygen-carrying pigment, an idea to which the present observation seems to me to yield considerable support. It is moreover readily bleached by light, another analogy to chlorophyll, as we know from Pringsheim's researches.

When one exposes an aquarium full of *Anthea* to sunlight, the creatures, hitherto almost motionless, begin to wave their arms, as if pleasantly stimulated by the oxygen which is being developed in their tissues. Specimens which I kept exposed to direct sunshine for days together in a shallow vessel placed on a white slab, soon acquired a dark, unhealthy hue, as if being oxygenated too rapidly, although I protected them from any undue rise of temperature by keeping up a flow of cold water. So, too, I found that Radiolarians were killed by a day's exposure to sunshine, even in cool water, and it is to the need for escaping this too rapid oxidation that I ascribe their remarkable habit of leaving the surface and sinking into deep water early in the day.

It is easy, too, to obtain direct proof of this absorption of a great part of the evolved oxygen by the animal tissues through which it has to pass. The gas evolved by a green alga (*Ulva*) in sunlight may contain as much as 70 per cent. of oxygen, that evolved by brown algæ (*Haliseris*) 45 per cent., that from diatoms about 42 per cent.; that, however, obtained from the animals containing *Philozoon* yielded a very much lower percentage of oxygen, *e.g. Velella* 24 per cent., white *Gorgonia* 24 per cent., *Ceriactis* 21 per cent, while Anthea, which contains most algæ, gave from 32 to 38 per cent. This difference is naturally to be accounted for by the avidity for oxygen of the animal cells.

Thus, then, for a vegetable cell no more ideal existence can be imagined than that within the body of an animal cell of sufficient active vitality to manure it with carbonic acid and nitrogen waste, yet of sufficient transparency to allow the free entrance of the necessary light. And conversely, for an animal cell there can be no more ideal existence than to contain a vegetable cell, constantly removing its waste products supplying it with oxygen and starch, and being digestible after death. For our present knowledge of the power of intracellular digestion possessed by the endoderm cells of the lower invertebrates removes all difficulties both as to the mode of entrance of the algæ, and its fate when dead. In short, we have here the relation of the animal and the vegetable world reduced to the simplest and closest conceivable form.

It must be by this time sufficiently obvious that this remarkable association of plant and animal is by no means to be termed a case of parasitism. If so, the animals so infested would be weakened, whereas their exceptional success in the struggle for

existence is evident. *Anthea cereus*, which contains most algæ, probably far outnumbers all the other species of sea-anemones put together, and the Radiolarians which contain yellow cells are far more abundant than those which are destitute of them. So, too, the young gonophores of Velella, which bud off from the parent colony and start in life with a provision of *Philozoon* (far better than a yolk-sac) survive a fortnight or more in a small bottle—far longer than the other small pelagic animals. Such instances, which might easily be multiplied, show that the association is beneficial to the animals concerned.

The nearest analogue to this remarkable partnership is to be found in the vegetable kingdom, where, as the researches of Schwendener, Bornet, and Stahl have shown, we have certain algæ and fungi associating themselves into the colonies we are accustomed to call lichens, so that we may not unfairly call our agricultural Radiolarians and anemones *animal lichens*. And if there be any parasitism in the matter, it is by no means of the alga upon the animal, but of the animal, like the fungus, upon the alga. Such an association is far more complex than that of the fungus and alga in the lichen, and indeed stands unique in physiology as the highest development, not of parasitism, but of the reciprocity between the animal and vegetable kingdoms. Thus, then, the list of supposed chlorophyll-containing animals with which we started, breaks up into three categories: first, those which do not contain chlorophyll at all, but green pigments of unknown function (*Bonellia, Idotea*, &c.); secondly, those vegetating by their own intrinsic chlorophyll (*Convoluta, Hydra, Spongilla*); thirdly, those vegetating by proxy, if one may so speak, rearing copious algæ in their own tissues, and profiting in every way by the vital activities of these.

PATRICK GEDDES

SCIENTIFIC SERIALS

Journal of the Royal Microscopical Society for December, 1881, contains:—Diatoms from Peruvian guano, by Rev. L. G. Mills (plate xi.).—B. W. Richardson, on multiple staining and the usual summary of current researches relating to zoology and botany (principally Invertebrata and Cryptogamia). — Microscopy.—This part concludes volume i. ser. ii., and is accompanied by a very excellent index to the 980 pages, a list of authors, and full tables of contents.

Transactions and Proceedings of the New Zealand Institute for 1880, vol. xiii. Wellington, April, 1881.—In this large volume of over 460 pages, in addition to a short account of the proceedings of most of the scientific societies of New Zealand, the following memoirs are published *in extenso*:—*Astronomical*: H. Skey, on periodic vertical oscillations in the Sun's atmosphere, and their connection with the appearance and disappearance of of the solar spots.—M. Chapman, on the permanency of solar and stellar heat.—A. W. Bickerton, on the causes tending to alter the eccentricity of planetary orbits,—On the origin of the solar systems.—On the origin of double stars.—On a simple method of illustrating the motions of the earth.—On the probability of impact.—*Zoological*: Julius von Haast, on *Balænoptera huttoni*, Gray.—On Harpagornis (3rd paper).—W. Arthur, on migratory salmon.—Dr. Hector, on a new fish.—F. E. Clark, on a new species of Trachypterus.—F. W. Hutton, contributions to New Zealand Malacology.—G. M. Thomson, New Zealand crustacea.—T. F. Cheeseman, new species of mollusca.—Prof. Liversidge, analysis of Moa egg-shell.—Capt. Broun, description of coleopterous larvæ and pupæ.—T. W. Kirk, notes on birds.—On crustacea.—P. Buller, on new diurnal moths.—W. L. Buller, a new lizard.—T. Jeffery Parker, a new species of Chirodota.—On the venous system of the skate.—*Botanical*: W. Colenso, on the vegetable food of the ancient New Zealanders.—On the ferns of Scinde Island (Napier).—On some new ferns of New Zealand.—On a new species of Metzgeria.—G. M. Thomson, on fertilisation in New Zealand flowers.—On *Donatia novæ-zealandiæ*.—Dr. Berggren, on New Zealand plants.—T. F. Cheeseman, on the fertilisation of Thelymitra.—On a new Loranthus.—W. M. Marskell, New Zealand Desmids.—T. A. Mollet, on the structure of *Hormosira billardieri*.—Dr. Petrie, flora of Stewart Island.—On a new Carex.—T. B. Armstrong, on the genus Corallospartium.—On new or rare New Zealand plants.—On the occurrence of the Morel.—On a natural arrangement of the New Zealand ferns.—T. Kirk, some new plants.—Charles Knight, on a new Thysanothecium.—*Chemical*: W. Skey, on an allotropic form of zinc and cobalt salts.—On a periodide and an iodo-carbonate of lead.—On the dimorphism of magnesia.—*Geological*: A. D. Dobson, on a dyke near Heathcote.—A. Hamilton, on the Foraminiferæ of the tertiary beds at Petane.—A. M'Kay, on the genus Rhynconella.—S. Percy Smith, on changes in coast line level in the north of the North Island.—T. A. Mollet, on an artesian well at Avonside.—This volume is illustrated with eighteen lithographic plates.

Zeitschrift für wissenschaftliche Zoologie, Bd. 36, Part 2 (Nov. 1881), contains:—Prof. Hubert Ludwig, on the history of the development of the skeleton in Ophiuroids (plates x. and xi.).—Dr. Julius Andreæ, contribution to the anatomy and histology of *Sipunculus nudus*, L. (plates xii. and xiii.).—Dr. F. Mayser, comparative anatomy studies on the brain of osseous fishes, with especial reference to the Cyprinoids (plates xiv. to xxiii.).

Atti della R. Accademia dei Lincei, vol. vi., fasc. 1.—The reactions of biliary pigments, by S. Capranica.—Synthesis of naphtil-acrylic acid, by F. Lugli.—Researches on the spider's web, by L. Valente.—On the light of the comet, by L. Respighi.

Atti della R. Accademia dei Lincei, vol. vi., fasc. 2.—On bilinear quaternary forms, by G. Battaglini.—On the origin of some linear differential equations, by S. Brioschi.—On the discharges of condensers, by Srs. Villari and Righi.—The endoptic perception of colour at the back of the eye, by C. Emery.—Contribution to the anatomy of leaves, by G. Briosi.—On dimethylnaphthaline, by G. Giovanozzi.—Reports, &c.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 8, 1881.—"On the Structure and development of *Lepidosteus*," by F. M. Balfour, LL.D., F.R.S., and W. N. Parker.

The first section of this paper is devoted to the general development. In this section an account is given of the structure of the ripe ovum, of the segmentation, of the history of the germinal layers, of the first development of the principal organs, and of the external features of the embryo during embryonic and larval life. The more important points established in this section are—

1. The ovum when laid is invested by a double covering formed of (*a*) a thick inner membrane, the outer zone of which is radially striated, and (*b*) an outer layer made up of highly refractive pyriform bodies, which are probably metamorphosed follicular epithelial cells.

2. The segmentation is complete, though very unequal, the lower pole being very slightly divided up into segments, and its constituent parts fusing together again to form an unsegmented mass of yolk, like the yolk-mass of Teleostei.

3. The epiblast is divided into an epidermic and nervous stratum, as in Teleostei.

4. The walls of the brain, spinal cord, and optic vesicle are formed from a solid medullary keel, like that found in Teleostei.

5. The lens, the auditory vesicle, and olfactory pit, are wholly developed from the nervous layer of the epidermis.

6. The segmental or archinephric duct is developed as in Teleostei, from a hollow ridge of the somatic mesoblast, which becomes constricted off, except in front, thus forming a duct with an anterior pore leading into the body cavity.

The section on the general development is followed by a series of sections on the adult anatomy and development of various organs.

The Brain.—The authors give a fuller description of the adult brain than has previously been given. The new features in this description are (1) that the parts identified by previous anatomists as the olfactory lobes are really parts of the cerebral hemispheres, the true olfactory lobes being small prominences at the base of the olfactory nerves; (2) that there is attached to the roof of the thalamencephalon a peculiar vesicle, which has not hitherto been noticed, but which is similar to the vesicle found by Wiedersheim on the roof of the thalamencephalon of Protopterus. They further show that the cerebrum is divided into a posterior portion, with an unpaired ventricle, and an anterior portion in which the ventricle is paired. They consider the presence of the portion of the cerebrum with an unpaired ventricle to be an indication that this part of the brain retains characters which are only found in the embryonic brain of other groups. They point to ths presence of lobi inferiores on the

infundibulum, of tori semicirculares in the mid-brain, and of a large cerebellum as indications of an affinity between the brain of Lepidosteus and that of Teleostei. In the embryological section full details are given as to the development of the thalamencephalon, the pineal gland, the cerebrum, and the olfactory lobes.

Organs of Special Sense: Eye.—In the adult eye a vascular membrane is described bounding the retinal aspect of the vitreous humour. This membrane is supplied by an artery piercing the retina close to the optic nerve, and the veins from it fall into a circular vessel placed at the insertion of the iris. The membrane itself is composed of a hyaline ground substance with numerous nuclei. In the developmental section devoted to the eye the main subject dealt with is the nature of the mesoblastic structures entering the cavity of the optic cup, through the choroid slit. It is shown that a large non-vascular mesoblastic process first enters the optic cup, and that together with the folded edge of the choroid slit it forms a rudimentary and provisional processus falciformis. At a later period an artery, bound up in the same sheath as the optic nerve, enters the optic cup, and the vascular membrane found in the adult then becomes developed.

The Suctorial Disk.—The structure of a peculiar larval suctorial organ placed at the end of the snout is described, and the organ is shown to be formed of papillæ constituted by elongated epidermic cells, which are probably glandular (modified mucous cells), and pour out a viscid secretion.

Muscular System.—The lateral muscles of Lepidosteus are shown to differ from those of other fishes, except the Cyclostomata, in not being divided into a dorso-lateral and ventro-lateral group on each side of the body.

Vertebral Column and Ribs.—The early stages in the development of the vertebral column are similar to those in Teleostei; the vertebræ being at first biconcave, and the notochord vertebrally constricted. Subsequently an invertebral growth of cartilage takes place, derived from the neural and hæmal arches, and gives rise to invertebral constrictions of the notochord.

The embryological part of this section is followed by a comparative part treated under three headings. In the first of these the vertebral column of Lepidosteus is compared with that of other forms; and it is pointed out that there are grave difficulties in the way of comparing the vertebræ of Lepidosteus with those of some Urodela in the fact that in Lepidosteus the intervertebral cartilages originate from the bases of the arches, while in the Urodela they are stated by Götte to be thickenings of a special cartilaginous investment of the notochord, which would seem to be homologous with the cartilaginous sheath placed in Elasmobranchii and Dipnoi *within the membrana elastica externa.*

On the other hand, the development of the vertebræ of Lepidosteus is shown to resemble in most features that of Teleostei, from which it mainly differs in the presence of intervertebral cartilaginous rings.

In the second section, devoted to the homologies of the ribs of Pisces, the conclusions arrived at are as follows:—

The Teleostei, Ganoidei, Dipnoi, and Elasmobranchii are provided with homologous hæmal arches, which are formed by the coalescence below the caudal vein of simple prolongations of the primitive hæmal processes of the embryo.

In the region of the trunk the hæmal processes and their prolongations behave somewhat differently in the different types. In Ganoids and Dipnoi, in which the most primitive arrangement is probably retained, the ribs are attached to the hæmal processes, and are placed immediately without the peritoneal membrane at the insertion of the intermuscular septa. These ribs are in many instances (Lepidosteus, Acipenser), and very probably in all, developed continuously with the hæmal processes, and become subsequently segmented from them. They are serially homologous with the ventral parts of the hæmal arches of the tail, which, like them, are in many instances (Ceratodus, Lepidosteus, Polypterus, and to some extent in Amia) segmented off from the basal parts of the hæmal arches.

In Teleostei the ribs have the same position and relations as those in Ganoids and Dipnoi, but their serial homology with the ventral parts of the hæmal processes of the tail is often (*e.g.* the Salmon) obscured by some of the anterior hæmal arches in the posterior part of the trunk being completed, not by the ribs, but by independent outgrowths of the basal parts of the hæmal processes.

In Elasmobranchii a still further divergence from the primitive arrangement is present. The ribs appear to have passed outwards along the intermuscular septa into the muscles, and are placed between the dorso-lateral and ventro-lateral muscles (a change of position of the ribs of the same nature is observable in Lepidosteus). This change of position, combined probably with the secondary formation of a certain number of anterior hæmal arches, similar to that in the Salmon, renders their serial homology with the ventral parts of the hæmal processes of the tail far less clear than in other types, and further proof is required before such homology can be considered as definitely established.

Under the third heading the skeletal elements supporting the fin-rays of the ventral lobe of the caudal fin of various types of fishes are compared and the following conclusions are arrived at.

1. The ventral lobe of the tail-fin of Pisces differs from the other unpaired fins in the fact that its fin-rays are directly supported by spinous processes of certain of the hæmal arches instead of by independently developed interspinous bones.

2. The presence or absence of fin-rays in the tail-fin supported by hæmal arches may be used in deciding whether apparently diphycercal tail-fins are aborted or primitive.

Urogenital Organs.—With reference to the character of the adult urogenital organs, the authors show that for the female the descriptions of Müller and Hyrtl are substantially accurate, but that Hyrtl's description of the generative ducts of the male is wholly incorrect.

They find that in the male the semen is transported from the testes by means of a series (40—50) of vasa efferentia, supported by the mesorchium. In the neighbourhood of the kidney these vasa unite into a longitudinal canal, from which transverse trunks are given off, which become continuous with the uriniferous tubuli. The semen is thus transported through the kidney into the kidney-duct (segmental duct), and so to the exterior. No trace of a duct homologous with the oviduct of the female was found in the male.

With reference to the development of the excretory system, the authors have established the following points:—

1. That the segmental (archinephric) duct is developed as in Teleostei.

2. That a pronephros, resembling in the main that of Teleostei, is developed from the anterior end of the segmental duct. But they found that the pronephric chambers, each containing a glomerulus, with which the coiled pronephric tube opens, are not, as in Teleostei, completely shut off from the body cavity, but remain in communication with it by two richly ciliated canals, one on each side of the body.

3. The pronephros eventually undergoes atrophy.

4. Some of the mesonephric tubes have peritoneal funnels in the larva.

5. The ovarian sac continuous with the oviduct, is established by a fold of the peritoneal membrane, near the attachment of the mesovarium uniting with the free edge of the ovarian ridge to form a canal, the inner wall of which is constituted by the ovarian ridge itself.

6. The posterior part of the oviduct is not formed until the ovarian sac has become developed, and had not been developed in the oldest larva (11 centims.) the authors have succeeded in obtaining.

The Alimentary Canal and its Appendages.—In this section the authors give a detailed account of the topographical anatomy of the alimentary tract in the adult. They have detected a small pancreas close to the bile-duct, and call special attention to a ventral mesentery passing from the posterior straight section of the intestine to the ventral wall of the body.

In the embryological part of the section a detailed account is given of the development (1) of the pancreas, which is described as emerging as a dorsal diverticulum of the duodenum on a level with the opening of the bile-duct; (2) of the yolk-sac and vitelline duct; (3) of the spiral valve, which first appears as a hollow fold in the wall of the intestine, taking a slightly spiral course, and eventually becoming converted into a simple spiral ridge. The so-called hyoid gill, which the authors expected to find well-developed in the larva, is shown not to be found even in the oldest larva examined (26 millims.)

The last section of the paper is devoted to the consideration of the systematic position of Lepidosteus. The Teleostean affinities of Lepidosteus are brought into prominence, but it is shown that Lepidosteus is nevertheless a true Ganoid.

The arguments used in this portion of the paper do not admit of being summarised.

Geological Society, January 11.—Mr. R. Etheridge, F.R.S., president, in the chair.—Messrs. W. J. Clunies Ross, Joseph William Brown, William Hunter, Henry Tomlinson, and Charles Otto Trechmann, were elected Fellows of the Society.—The following communications were read:—On the chalk masses or boulders included in the contorted drift of Cromer, their origin and mode of transport, by T. Mellard Reade, F.G.S.—Observations on the two types of Cambrian beds of the British Isles (the Caledonian and Hiberno-Cambrian), and the conditions under which they were respectively deposited, by Prof. Edward Hull, LL.D., F.R.S. In this paper the author pointed out the distinctions in mineral character between the Cambrian beds of the North-West Highlands of Scotland and their assumed representatives in the east of Ireland and in North Wales. In the former case, which included the beds belonging to the "Caledonian type," the formation consists of red or purple sandstones and conglomerates; in the latter, which included the beds belonging to the "Hiberno-Cambrian type," the formation consists of hard green and purple grits and slates contrasting strongly with the former in structure and appearance. These differences the author considered, were due to deposition in distinct basins lying on either side of an Archæan ridge of crystalline rocks which ranged probably from Scandinavia through the central highlands of Scotland, and included the north and west of Ireland, with the counties of Donegal, Derry, Mayo, Sligo, and Galway—in all of which the Cambrian beds were absent—so that the Lower Silurians repose directly and unconformably on the crystalline rocks of Laurentian age. As additional evidence of the existence of this old ridge, the author showed that when the Lower Silurian beds were in course of formation, the Archæan floor along the west of Scotland must have sloped upwards towards the east; but he agreed with Prof. Ramsay that the crystalline rocks of the Outer Hebrides formed the western limit of the Cambrian area of deposition, and that the basin was in the form of an inland lake. On the other hand, looking at the fossil evidence both of the Irish and Welsh Cambrian beds, he was of opinion that the beds of this basin were in the main, if not altogether, of marine origin, and that the basin itself had a greatly wider range eastward and southward—the old Archæan ridge of the British Isles forming but a small portion of the original margin.—The Devono-Silurian formation, by Prof. E. Hull, LL.D., F.R.S. The beds which the author proposed to group under the above designation are found at various parts of the British Isles, and to a slight extent on the Continent. The formation is, however, eminently British, and occurs under various local names, of which the following are the principal:—England and Wales—Devonshire: The Foreland Grits and Slates lying below the Lower Devonian beds ("Lynton Beds"). Welsh Borders: "The passage-beds" of Murchison, above the Upper Ludlow Bone-bed, and including the Downton Sandstone, and rocks of the Ridge of the Trichrug. These beds form the connecting link between the Estuarine Devonian beds of Hereford (generally, but erroneously, called the "Old Red Sandstone") and the Upper Silurian Series. South-east of England (Sub-Cretaceous district): The author assumed, from the borings at Ware, Turnford, and Tottenham Court Road described by Mr. Etheridge, that the Devono-Silurian beds lie concealed between Turnford and Tottenham Court Road on the south and Hereford on the north. Ireland—South: "The Dingle beds," or "Glengariff Grits and Slates," lying conformably on the Upper Silurian beds, as seen in the coast of the Dingle promontory, and overlain unconformably by either Old Red Sandstone or Lower Carboniferous beds, 10,000 to 12,000 feet. North: "The Fintona beds," occupying large tracts of Londonderry, Monaghan, and Tyrone, resting unconformably on the Lower Silurian beds of Pomeroy, and overlain unconformably by the Old Red Sandstone or Lower Carboniferous beds, 5000 to 6000 feet in thickness. Scotland: Beds of the so-called "Lower Old Red Sandstone," with fish and crustaceans, included in Prof. Geikie's "Lake Orcadie, Lake Caledonia, and Lake Cheviot," underlying unconformably the Old Red Sandstone and Lower Calciferous Sandstone, and resting unconformably on older crystalline rocks. Thickness in Caithness about 16,200 feet. The author considered that all these beds were representative of one another in time, deposited under Lacustrine or Estuarine conditions, and as their name indicated, forming a great group intermediate between the Silurian on the one hand and the Devonian on the other. He also submitted that their importance, as indicated by their great development in Ireland and Scotland, entitled them to a distinctive name such as that proposed.

Zoological Society, January 17.—Prof. W. H. Flower, F.R.S., president, in the chair.—Prof. A. Newton, F.R.S., exhibited (by favour of Messrs. Hallett and Co.) the skin and bones of the trunk of an example of *Notornis mantelli* recently received from New Zealand. This was stated to be the third example of this almost extinct bird which had been yet obtained.—Mr. W. K. Parker, F.R.S., read a memoir on the structure and development of the skull in the Crocodilia.—Mr. Oldfield Thomas gave an account of a series of Rodents lately collected by Mr. Stolzmann in Northern Peru. The chief interest in the collection was stated to lie in the fine series of Mice of the genera *Hesperomys* and *Holochilus* contained in it.—A communication was read from Mr. T. E. Buckley on the variability of plumage exhibited by the Red Grouse.—A communication was read from Mr. G. B. Sowerby, jun., containing descriptions of some new species of shells in the collection of Mr. J. Cosmo Melvill.—Prof. F. Jeffrey Bell read descriptions of several new or rare species of *Asteroidea* contained in the collection of the British Museum.—A communication was read from Mr. W. L. Distant, containing the characters of some undescribed species of *Cicadidæ* from the Australian and Pacific regions.

Meteorological Society, January 18.—Mr. G. J. Symons, F.R.S., president, in the chair.—The Secretary read the Report of Council for the past year, which showed the Society to be in a very flourishing condition, for while in 1871 the Society continued its work without an office, accessible library, or an assistant secretary, and the number of the Fellows was 314; the staff at present very fully employed consists of an assistant secretary and three computers with 555 Fellows on the roll. The receipts and expenditure in 1871 show a marked contrast to the year just past; the receipts amounted to only 244*l.* against more than 840*l.* in 1881. The expenditure was only 197*l.* against 780*l.* in 1881. The Society also now receives Second Order and Climatological Observations from eighty-three stations, the results of which are published quarterly in the *Meteorological Record*. In addition to the *Quarterly Journal*, two publications have been prepared and issued under the direction of the Council, viz. "Hints to Meteorological Observers, with Instructions for taking Observations and Tables for their Reduction," and "Index to the Publications of the English Meteorological Societies, 1839 to 1881."—The President then delivered his address, which was devoted to the consideration of the present state and future prospects of Meteorology. He began by asking in what respects is our present system of observation capable of improvement? Should it be extended, either as regards distribution of stations, additional instruments, or additional hours of observation? Can any of the millions of entries at present made annually be safely dispensed with? These questions can only be properly answered after considering two others—What observations are being made? and for what object? After referring to the different patterns of barometer and the number of observations made, Mr. Symons said that he is aware there are several grounds upon which the maintenance of numbers of stations in excess of all possible requirements can be defended. In the first place there is the constant difficulty which arises from the removals and deaths of the observers, and from the extension of buildings and growth of trees, &c. This renders it necessary that we should have two or three stations wherever we desire to make sure of a continuous record. But a far better and more scientific plan would be to choose a few unexceptional localities remote from towns, purchase the freehold of a few surrounding acres, erect thereon stations, identical in design and in every respect, and endow them with moderate funds so that the observations may, humanly speaking, be established on an unalterable basis. That would be the way to detect secular changes. For climatic purposes the numerous climatological stations started by the Society are of great value. After speaking of hygrometers, anemometers, and ozonometers the President referred to daily maps of Atlantic weather, which should be on a scale of not less than 1 inch for 100 miles. A compilation of such charts is essentially national work, and falls wholly within the domain of the Government Office. After referring to weather forecasts, the lack of original workers in discussing meteorological observations, the absence of academical encouragement, and the little prospect of those who devote themselves to meteorology obtaining more than a bare livelihood, the President concluded as follows:—"It is just possible that the severe manner in which I have criticised a few of our existing arrangements may have led some one to consider that meteorology is languishing, feeble, or moribund. I believe that the very contrary is the fact; when

a case is weak, one hesitates to point out its weaknesses for fear of a total collapse. No. The Meteorological Society never advanced so rapidly in numbers as it has in the two last years, and if it will but apply the pruning knife to fruitless observations and try to secure the application of more brain power to the many problems yet unsolved, it will contine to receive an ever-increasing amount of recognition and support, and to maintain that high position among kindred societies which it at present holds."—The following gentlemen were elected Officers and Council for the ensuing year:—President, John Knox Laughton, M.A., F.R.A.S., F.R.G.S. Vice-Presidents: William Ellis, F.R.A.S., Rogers Field, B.A., Joseph Henry Gilbert, F.R.S., Baldwin Latham, F.G.S. Treasurer, Henry Perigal, F.R.A.S. Trustees: Hon. Francis Albert Rollo Russell, M.A., Stephen William Silver, F.R.G.S. Secretaries: George James Symons, F.R.S., John William Tripe, M.D. Foreign Secretary, Robert Henry Scott, F.R.S. Council: Edmund Douglas Archibald, M.A., Arthur Brewin, F.R.A.S., John Sanford Dyason, F.R.G.S., Edward Ernest Dymond, Henry Storks Eaton, M.A., Charles Harding, Robert John Lecky, F.R.A.S., William Marcet, F.R.S., Edward Mawley, F.R.H.S., Richard Strachan, George Mathews Whipple, F.R.A.S., Charles Theodore Williams, M.D.

Paris

Academy of Sciences, January 16.—M. Jamin in the chair.—The following papers were read:—On the velocity of propagation of explosive phenomena in gases, by MM. Berthelot and Vieille. These experiments were fuller and more exact than the former. An explosive mixture of H and O in a straight horizontal lead tube about 40 m. long and 0·005 m. internal diameter, was fired at one end with an electric spark, and the travelling flame broke two electric circuits in passing (by acting on fulminate of mercury). Again, the tube was divided into a series of connected parallel pieces. For both cases the high general average of 2841 m. per second was obtained. The same with a caoutchouc tube (excluding the idea of a vibratory motion of metal inducing rupture of the circuits). With narrower capillary glass tubes the mean was 2341 m. The velocity was not affected by one or other orifice, or both, or neither, being open. The propagation was uniform in the tubes. The velocity was independent of pressure. CO and O gave a velocity of 1089 m., and dilution of the other mixture with air reduced the velocity.—Chemical studies on the skeleton of plants; second part, vasculose, by MM. Frémy and Urbain. Vasculose most abounds in the parts that present resistance or hardness. To get it pure, the authors treat elder pith with weak hydrochloric acid, the ammoniaco-cupric reagent, &c. *Inter alia*, atmospheric oxygen seems, in time, to transform vasculose into resinous acids soluble in alkalies. In reaction of fused alkalies on wood, it is the vasculose only that forms the different ulmic acids; while cellulose produces acetic and oxalic acid. Methylic alcohol is specially generated by vasculose. The composition of vasculose is $C_{36}H_{20}O_{16}$. Many vegetable fibres (hemp, &c.) have a layer of vasculose, the thickness of which has influence in retting, bleaching, and dyeing.—On the mode of publication most favourable to the progress of scientific studies, by M de Saint-Venant. He urges the printing of mathematical and other works on such paper as will allow of annotations, in ink, by the reader.—On two small epidemics of plague in Khorassan, by M. Tholozan. This region, thought refractory to plague, has been attacked in a way which is apparently not explained by contagion.—M. Hirn gave some account of a controversy between himself and M. Zeuner, relative to steam-engine cylinders.—M. Gaudry was elected Member in Mineralogy, in place of the late M. Sainte-Claire Deville.—On the spherical representation of surfaces, by M. Darboux.—New theorems on the indeterminate equation $ax^4 + by^4 = z^2$, by M. Pepin.—On an extension of the arithmetical notion of genus (continued), by M. Poincaré.—On waves produced in water at rest in a canal, by immersion of a solid cylinder plunged crosswise into the canal, by M. Boussinesq.—Influence of the form of polar surfaces on the explosive potential, by M. Baille. The results with concentric cylinders and spheres of different diameters (exterior to each other) are given. In the latter case, for a given explosive length, the potential is maximum when the spark passes between two spheres of the same diameter; and it departs from the maximum more, the greater the difference of curvature and the higher the potential.—On the essence of savory, by M. Haller.—On a diatomic alcohol derived from β naphtol, by M. Rousseau.—Phosphoric acid in the arable land of the north of France, by M. Ladureau. A farmer at Honplin (Nord), for twenty years grew beet and wheat alternately on the same land, to which he applied, every two years, the *vinasses* (or liquid residue) of a distillery he had, and a very little dung. The beet kept good, but the wheat crop steadily went down. M. Ladureau showed that the ground had too little phosphoric acid. The evil was remedied by large use of soluble and insoluble phosphates of lime.—Discovery of some new genera of fossil mammalia in the deposits of phosphate of lime at Quercy, by M. Filhol. One belongs to the Moschidæ, and is to be placed near Gelocus. The other resembles Cainotherium. The deposits belong to the Upper Eocene.—Anatomical researches on *Spatangus purpureus*, by M. Kœhler.—On the discordance between the respiratory variations of the intracarotidian and the intrathoracic pressure; second note by M. Fredericq.—On the interpretation of the weight of the brain and its applications, by M. Manouvrier. The increase of mass of the body is a cause of increase of absolute, but of diminution of relative, cerebral brain-weight. He offers an explanation of this in mathematical form, based on the fact that the development of the intellectual faculties is not proportional to that of the body. The impossibility of ranking species and individuals hierarchically according to weight of brain did not arise from the imperfection of the term of comparison chosen between the brain and the mass of the body (as some suppose). The author finds a more suitable term in the *skeleton*. The portion of the brain whose development is in ratio of the intellectual faculties serves for classifying hierarchically; man is then above all animals; and different races, &c., take their right places.—Contributions to the geological knowledge of Japan, by M. Metchnikoff show that Japan is not so exclusively volcanic as has been supposed.

Vienna

Imperial Academy of Sciences, January 5.—V. Burg in the chair.—The following papers were read:—Albert von Ettingshausen, determination of the index of diamagnetism of metallic tungsten in absolute measure.—Dir. Hann, on the temperature of the southern hemisphere.

January 12.—V. Burg in the chair.—The following papers were read:—E. Mach, on the fundamental notions of electrostatics.—G. Gruss, determination of the trajectory of the Comet V. 1877 (it is found to be a parabola).—T. Haubner, on the stationary streaming of electricity through flat-shaped conductors.—A. v. Obermayer, on the diffusion of gases.

Imperial Institute of Geology, January 10.—The anniversary meeting was held.—Franz v. Hauer gave the president's address. Then the following papers were read:—Fr. Kraus, on finds of remains of *Ursus spelæus* in the Dachstein Mountains.—Edm. v. Mojsisowic, on the Russian Triassic formations.—V. Uhlig exhibited geological maps of the North-Eastern Transylvania.

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THURSDAY, FEBRUARY 2, 1882

SCIENTIFIC WORTHIES

XIX.—Adolf Erik Nordenskjöld

FEW men have done more varied and real service for science than Baron Nordenskjöld, whose portrait we are pleased to include in our Gallery of Scientific Worthies. The present seems an appropriate time to do so, when Nordenskjöld has crowned the labours of half a lifetime by recounting the story of his greatest achievement, and put the finishing touch to centuries of effort. Baron Nordenskjöld is known to most as the successful Arctic explorer and navigator, but his claims to be regarded as a worthy of science rest on a much wider basis.

Adolf Erik Nordenskjöld was born at Helsingfors, the capital of Finland, on November 18, 1832, the third in order of seven children, four brothers and three sisters, all of whom, with the exception of a sister who died young, still survive. His parents were Nils Gustaf Nordenskjöld, a well-known naturalist, chief of the mining department of Finland, and Margareta Sofia von Haartman. The race from which Nordenskjöld sprang had been known for centuries for the possession of remarkable qualities, among which an ardent love of nature and of scientific research was predominant. Its founder is said to have been a Lieut. Nordberg, who was settled in Upland about the beginning of the seventeenth century His son, Johan Erik, born 1660, changed the name to Nordenberg. He died in 1740, leaving two sons, Anders Johan and Carl Frederik, both of whom, though the latter was only lieutenant, were elected members of the Swedish Academy of Sciences when it was founded in 1739. Both were ennobled in 1751. Carl Frederik is the common ancestor of the families bearing the name of Nordenskjöld now living in Sweden and Finland. One of his many remarkable sons, the third in order, Col. Adolf Gustaf Nordenskjöld, became owner of Frugord in Finland. This property, situated in a forest-crowned valley in the department of Nyland, is still in the possession of the Nordenskjölds. Here Col. Adolf Gustaf Nordenskjöld built a peculiar residence, the middle of which is taken up with a hall two stories high, round the upper part of which runs a broad gallery in which collections in natural history are arranged. His youngest son, Nils Gustaf, was born in 1792. After passing his examination in mining at the University of Upsala he was for several years a pupil of Berzelius, with whom he formed the warmest friendship, which was only broken off by death. Nils Gustaf, early known as a distinguished mineralogist, was appointed a government inspector of mines in his native country, and by means of liberal grants of public money was enabled to undertake extensive foreign tours, which brought him into communication with most of the eminent mineralogists and chemists of the day in England, France, and Germany. After three years of foreign travel he returned to Finland, and was promoted in 1824 to be chief of the mining department, and devoted thirty years of restless activity to the improvement of that important branch of the industry of his native land. He travelled through Finland in all directions in the prosecution of his untiring mineralogical and geological researches. His travels extended as far as the Ural. He published his views, discoveries, and experiments, in many scientific periodicals and in several independent works, and a large number of minerals discovered by him afford evidence of his keen research. He was made Councillor of State, and obtained many distinctions for his scientific services from the sovereign and from learned bodies. On February 21, 1866, he ended his active life at Frugord, and was laid to rest in his father's grave.

Adolf Erik while yet a boy was an industrious collector of minerals and of insects, and was permitted to accompany his father on his tours, acquiring thus early the keen eye of the mineralogist. After studying for some time with a private tutor he was sent to the gymnasium at Borgo, where, as at similar institutions elsewhere, there then prevailed, as he tells us in the autobiographical sketch which he wrote for Bejer's "Swedish Biographical Lexicon," an almost unlimited freedom, the teachers taking no oversight whatever of the pupils' attention to their studies.

Nordenskjöld entered the University of Helsingfors in 1849, devoting himself chiefly to the study of chemistry, natural history, mathematics, physics, and above all, of mineralogy and geology. "Already, before I became a student," he writes, "I had been allowed to accompany my father in mineralogical excursions, and had acquired from him skill in recognising and collecting minerals and in the use of the blowpipe, which he, being a pupil of Gahn and Berzelius, handled with a masterly skill unknown to most of the chemists of the present day. I now undertook the charge of the rich mineral collection at Frugord, and besides, during the vacations made excursions to Pitkeranta, Tammela, Pargas, and others of Finland's interesting mineral localities. By practice I thus acquired a keen and certain eye for recognising minerals, which has been of great service to me in the path of life I afterwards followed."

After passing his candidate examination in 1853, Nordenskjöld accompanied his father on a mineralogical tour to Ural devoting most of his attention to Demidoff's iron and copper mines at Tagilsk. Here he planned an extensive journey through Siberia, but the breaking out of the Crimean war put a stop to it.

"After my return," says Nordenskjöld, "I continued to prosecute my chemical and mineralogical studies with zeal, and wrote as my dissertation for the degree of Licentiate a paper 'On the Crystalline Forms of Graphite and Chondrodite,' which was discussed under the presidency of Prof. Arppe on the 28th of February, 1855. The following summer I was employed on a work of somewhat greater extent—'A Description of the Minerals found in Finland,' which was published the same autumn. Various short papers in mineralogy and molecular chemistry were printed in *Acta Societatis scientiarum Fenniæ:* I also published, along with Dr. E. Nylander, 'The Mollusca of Finland' (Helsingfors, 1856), as an answer to a prize question proposed by one of the faculty. In the interval I had been appointed Curator of the Mathematico-Physical faculty, and had obtained a post at the Mining Office as mining engineer extraordinary, with inconsiderable pay, and an express understanding that no service would be required from me in return. A salary was also attached to my curatorship."

Nordenskjöld, however, did not long hold these appointments, having incurred the wrath of von Berg, the governor of Finland, for being present at a dinner at which, with the thoughtlessness of youth, there was some liberal talk and free singing. This was in November 1855, and Nordenskjöld resolved to take advantage of his rustication to travel. He went to Berlin, where he stayed during the spring and early summer of 1854, working in Rose's laboratory at researches in mineral analysis. Returning to Finland the same year, he had hoped to obtain a travelling scholarship, meaning to devote himself to Siberia, but was disappointed. He, however, obtained a stipend for a line of study through Europe in 1857. Before leaving he attended the Promotion Festival of that year, where he was to take his Master's and Doctor's degrees. At the Festival there was more liberal talk, which von Berg construed into "high treason," and Nordenskjöld thought it advisable to leave Finland for a time. He crossed over to Sweden, where he ultimately became naturalised, and rose to eminence both in public life and as a worker in science. Since 1862, however, Nordenskjöld had been allowed to go to Finland as often as he pleased, and would have been, in 1867, appointed Professor of Mineralogy in the University of Helsingfors, had he been able to promise to abjure politics, which he could not do entirely. By this time (July 1, 1863) he had married a Finnish lady (Anna Mannesheim, daughter of ex-President Count Carl Mannesheim). In 1858 Nordenskjöld took part in the first expedition to Spitzbergen, organised by Sorell, the head of the Swedish Geological Survey. To these and other voyages of Nordenskjöld we referred at some length in vol. xx. pp. 606, 631, and further details will be found in Mr. Leslie's "Arctic Voyage of A. E. Nordenskjöld," published by Macmillan and Co. in 1879, to which we are mainly indebted for the details of the present article. On his return from this voyage in the autumn of 1858 Nordenskjöld was appointed successor to Mosander in the Mineralogical department of the Riks Museum at Stockholm. Meantime he had been engaged mainly in the practical study of the mineralogy of Scandinavia.

"Immediately after my return to Stockholm I entered on my new employment and began to work partly at the arrangement of the museum, partly at scientific researches which formed the subjects of several of my papers published either in the Transactions of the Academy of Sciences or of the Geological Society. At Prof. Mosander's death, when the rebuilding of the Academy's house had just begun, the mineralogical collection was stufled into three small rooms, where there was so little space that the exhibition of the collection could not be thought of. The new spacious apartments intended for the Riks Museum were finished in the summer of 1865, and already by the following autumn the arrangement and removal of the collections were so far advanced that the Museum could be opened to the public. It has since been my constant endeavour to enlarge the collection not only by purchases from dealers in minerals, but mainly by visits to the most important mineral localities in Scandinavia, undertaken on account of the Museum, partly by the Intendent himself, partly by Assistant Lindström, or by students of mineralogy from the Universities. In consequence of the extraordinary richness of the Scandinavian peninsula in rare and remarkable minerals, the Mineralogical Museum at Stockholm, with the help of the collections, valuable in certain directions, which have existed from Mosander's time, has in this way become one of the most considerable in Europe."

Nordenskjöld still continued to travel in search of minerals through various parts of Sweden and Norway. In 1861 he took part in another expedition to Spitzbergen under Torell, and in December, 1862, he crossed on the ice from Sweden to Finland, in order to make some investigations on the formation of sea-ice. In 1864 another expedition was made to Spitzbergen in connection with the measurement of an arc of meridian, and in the following year he was busy with further mineralogical investigations both in Sweden and Finland. In 1867 an agreeable change came in the form of a visit to Paris in connection with the Metric Commission, and the Exhibition of that year gave Nordenskjöld an opportunity of making the acquaintance of many eminent men of science. In the summer of 1868 Nordenskjöld found himself at the head of an expedition on a much larger scale than any of his previous ones, and partly fitted out at the Government expense. Rich and important scientific collections were brought home, and they reached the highest northern latitude which any vessel could be proved to have attained in the old hemisphere at that time. Among the contributors to this expedition was Mr. Oscar Dickson of Gothenburg, whose name is inseparably connected with Nordenskjöld's Arctic researches, and who has continued ever since to contribute to his expeditions with unprecedented liberality. Mr. Dickson, as is evident from his name, is of British origin, his father having been a native of Scotland who many years ago settled in Sweden. Previous to and preparatory for his next expedition, Nordenskjöld in 1870 visited Greenland, in company with Dr. Berggren, with results of the greatest value; some of which he refers to as follows:—

"The collection of new contributions to the flora of the Polar countries during several preceding geological periods of special importance for a knowledge of the history of the development of our globe. The discovery in the Miocene basaltic strata of Greenland at Ovifak, on the island Diskö, of the largest known blocks of meteoric iron, regarding the origin of which an extensive scientific controversy has arisen, and which perhaps will at some future time form the starting point for quite a new theory of the method of formation of the heavenly body we inhabit. The large blocks were brought home the following year by two vessels of war which were sent out to Greenland for that purpose by the Swedish Government, under the command of Baron von Otter.

"An excursion of some length was made into the wilderness of ice, everywhere full of bottomless clefts, which occupies the interior of Greenland, and which, if I except unimportant wanderings along the edge and an inconsiderable attempt in the same direction in the year 1728, by the Dane Dalager, was now, for the first time, trodden by human foot. I had here an opportunity of clearing up the nature of a formation which, during one of the latest geological ages, covered a great part of the civilised countries of Europe, and which, though it has given occasion to an exceedingly comprehensive literature in all cultivated languages, *had never before been examined by any geologist*. The equipment for the journey was exceedingly defective, because everybody with whom I conversed who had any knowledge of the circumstances, declared to me that such a journey was impracticable, and that in consequence my preparations were thrown away. It was on this account that I was compelled to return earlier than would otherwise have been the case."

One object of Nordenskjöld's going to Greenland was to discover whether dogs could be used in Spitzbergen for extensive sledge journeys, with the result that he found that they could not be employed "in long sledge journeys in the regions where no game was to be had."

Nordenskjöld had not ceased to take an interest in public affairs, and represented the capital of Sweden in the Diet for 1869 to 1871, during which he managed to bring about some important legislative measures for the better promotion of science. In the Spitzbergen Expedition of 1872-73 Nordenskjöld spent the winter in Mussel Bay, the state of the ice having been in an unusually unfavourable condition. Among the results of the expedition Nordenskjöld mentions the following:—

"The discovery on the Polar-ice itself of a dust of cosmic origin, containing metallic nickel-iron; researches by Dr. Kjellman on the development of algæ during the winter night, which at Mussel Bay is four months long; researches on the Aurora and its spectrum by Dr. Wijkander and Lieut. Parent, of the Italian Marine; researches by Dr. Wijkander on horizontal refraction in severe cold; a complete series of meteorological and magnetic observations in the most northerly latitude where such observations had up to this time been carried on; the discovery of numerous new contributions to a knowledge of the flora of the Polar countries during former geological epochs; a sledge excursion undertaken under very different circumstances by Palander and myself, whereby the north part of North East Land was surveyed, and a journey, very instructive in a scientific point of view, made over the inland ice of North East Land, &c., &c."

Then, in 1875, followed the expedition to the mouths of the Yennissei and Obi, the first of a series which culminated in the circumnavigation of Europe and Asia, of which we have just had such a full and instructive narrative.

Thus no one man has done half so much as Baron Nordenskjöld for a scientific exploration of the Arctic regions. The most striking characteristics of his various expeditions have been the small expense at which they were conducted, their modest but carefully-considered equipment, the clear and scientific methods on which they were planned, and the wealth and high value of the results obtained. In the intervals between the expeditions, Nordenskjöld was by no means idle. Not only was he occupied with his official duties as chief of the Stockholm Museum, but his researches in mineralogy, on the origin and constitution of meteors, on auroræ, and, in other important departments, are of the greatest moment. In 1876 he took part as a commissioner in the Philadelphia Exhibition; when he returned on July 1 of that year he stepped on board the vessel that was to take him on his second expedition to the Yennissei. Of his valuable investigations on auroræ and meteorites we give the first of a series of articles on the former subject on p. 319.

As to the personal character of Baron Nordenskjöld we need say little, his modesty and geniality are well-known, and his aversion to public display. He has in his adopted country risen to the highest honours, and as a well-earned reward for the success of his last expedition, the King of Sweden, his warm supporter, conferred on him the title of Baron. From scientific societies all over the world he has received honours. He is only yet in his prime; he is even now preparing for another expedition to the shores of Siberia, and we trust he may long be spared to carry on the work in which it would be difficult to find a successor.

THE POSSIBILITY OF FINDING WORKABLE COAL-SEAMS UNDER THE LONDON AREA

In a lecture recently delivered at the London Institution, an attempt was made to lay before a popular audience the course of reasoning, by which geologists have demonstrated that productive Coal-Measures may not improbably lie at no great depth beneath the metropolitan districts. The verification of the prediction that a ridge of Palæozoic rocks would be found to extend at a moderate depth beneath London, which has resulted from the borings made by Messrs. Meux and Co. in the Tottenham Court Road, and by the New River Company at Turnford and Ware, has renewed the interest which geologists have long taken in the question; and as the people of the metropolis now pay something like £5,000,000 a year for the carriage of coal from a distance, it appeared to be not unlikely that the general public might also be brought to take an intelligent interest in this important problem.

The discussion of the subject which has since taken place in the newspapers shows that such an expectation was not altogether unreasonable. But it must at the same time be confessed that some of the writers who have dealt with the subject have shown such a total misapprehension of the true nature of the problem, as to render it advisable to give in the pages of NATURE some explanations of the positions taken up by geologists in connection with the whole question.

As long ago as the year 1826, Dr. Buckland and Mr. Conybeare, in describing the features of the Bristol and Somerset coalfield, took occasion to point out how closely the Coal-Measures of that district resemble those of the great Belgian coalfield. This resemblance can be traced not only in the nature and succession of the strata in the two coalfields, but also in their positions and relations.

In the year 1841 MM. E. de Beaumont and Dufrénoy called attention to the fact that coal had been followed under newer beds in the North of France, and that possibly the same ridge of old rocks with coal-strata might stretch right away under the south-eastern counties of England.

In 1846 Sir Henry de la Beche gave much greater precision to the suggestion, and wrote as follows:—"From the movement of the older rocks many a mass of Coal-Measures may be buried beneath the Oolites and Cretaceous rocks on the east (of the Bristol Coalfield), connecting that district with those of Central England and Belgium, rolled about and partially denuded prior to the deposition of the New Red Sandstone."

In 1852 M. Meugy pointed out that it was by no means improbable that the coal basins of Belgium and Northern France would be found to extend right under the London basin.

But it is to Mr. Godwin-Austen that we are indebted for the most complete and philosophical discussion of the whole problem. In his well-known paper read before the Geological Society in 1855, he showed that the Coal-Measures, which had been proved to thin out under the

Chalk near Théronanne, would probably be found to make their appearance again near Calais, and to be prolonged beneath the Chalk and Tertiary beds along a line parallel to, if not coincident with, that of the North Downs, and thence away towards the Bristol and Somersetshire Coalfield.

In the Report of the Coal Commission, published in 1871, Prof. Prestwich has very ably argued the whole question, and brought forward a large amount of new evidence bearing upon it.

That geologists were right in their prediction of the existence of a ridge of Palæozoic rocks (the Axis of Artois), extending under the metropolitan area, has now been abundantly proved by boring operations. The strata of the Bristol and Somerset Coalfield have been traced and worked for a distance of about six miles under the overlying younger strata. That these overlying strata tend to thin away as they are followed towards the east has been proved by Prof. Hull and other geologists who have studied the Trias, Lias, and Oolites of the Midland district; and Prof. Prestwich has shown from a boring made at Oxford that the whole of the Lias and Oolites, which to the westward are several thousands of feet thick, beneath that city, are reduced in thickness to 420 feet. At Burford, in Oxfordshire, Coal-measure strata have actually been proved to exist at a depth of 1184 feet from the surface, and at Northampton at 830 feet. At Harwich, Carboniferous strata were found at a depth of 1026 feet; at Ostend, Palæozoic rocks were found at 975 feet; and at Vilvorde, near Brussels, at about 600 feet. These facts serve to show that a great attenuation of the Mesozoic strata takes place, as they were followed towards the south-east, and that the Palæozoic rocks are brought by so much nearer to the surface.

To the eastward, where the strata of the Belgian coalfield are found to be covered by overlapping younger strata, the productive measures have been followed by the enterprising French mining engineers, by means of pits sunk through the tertiaries and chalk, and in this way valuable coal supplies have been obtained along nearly the whole of the line from Mons and Charleroi to Lillers. At Hardinghen, between Calais and Boulogne, coal-measures are, in consequence of upheaval and denudation, exposed at the surface, while near the former town, strata of Carboniferous age have been found at a depth of 1138 feet.

The interesting experimental boring put down at Battle in Sussex, in order to prove the depth of the oolites beneath the Wealden, resulted in a very interesting discovery. It was found that in this district the Jurassic strata are of considerable thickness, and that it is therefore hopeless to attempt to reach the Palæozoic axis in that part of the Wealden area.

Five deep borings have however demonstrated the very moderate depth at which the Palæozoic rocks lie in the Metropolitan district. At Tottenham Court Road the Palæozoic ridge was found at a depth of 1066 feet; at Kentish Town at 1114 feet; at Turnford, near Cheshunt, at 940; at Ware at 796 feet; and at Crossness, near Erith, at 1008 feet. The exact age of the beds reached at Kentish Town and Crossness is somewhat doubtful, but at Tottenham Court Road and at Turnford the Upper Devonian was found, and at Ware the Wenlock shales of the Upper Silurian. We are indebted to Mr. Etheridge for a careful study of these borings, and for the determination of the numerous fossils obtained from them.

Another interesting fact demonstrated by these borings is that the strata lie at very high angles, the dip found at Tottenham Court Road being 36°, and that at Ware 30°.

The evidence obtained from these borings proves that the rocks forming the old Palæozoic ridge are bent into a series of east and west folds, and among these folds it is highly probable that Coal-measure strata will be found.

As to the point at which a boring might be put down with the greatest chance of success, several different opinions exist.

Prof. Prestwich thinks that a point in the southern suburbs of London, such as Sydenham or Croydon, is well worthy of being selected as the site for a new trial, and he points out that, even if coal were not found, the Lower Greensand might be met with, and this would in all probability be found to afford such an abundant supply of excellent water that the money expended in the investigation would not be thrown away.

Mr. Godwin-Austen, believing that a probable correspondence will be found to exist between the modern and ancient lines of disturbance, suggests some point near the North Downs, which is the axis of a great post-Cretaceous flexure, as the most hopeful one.

Some authorities have favoured the idea that it will be wise to avoid the task of sinking through the chalk, by commencing south of the North Downs, while others, foreseeing some difficulties in putting down borings and shafts through the loose running sands of the Folkestone beds, are in favour of a renewed attempt in more northern points of the Wealden district. But in face of the facts revealed by the Battle boring and the known thickness of the Wealden, it may well be doubted if it would be advisable to commence so far away from the proved position of the Palæozoic axis.

The coal-basins, if they exist on this Palæozoic ridge, are probably long and narrow in form, like those of Belgium and Northern France, having their longer axes directed from east to west. We now know that the Palæozoic ridge lies at depths varying from 800 to 1200 feet below the surface in the London district. As coal is profitably worked in many pits in this country more than 2000 feet deep, there is no reason why the coal, if discovered, should not be mined under London. We are now, therefore, in a position to state what are the requirements for a systematic search for coal under this city, and the conditions under which that search must be made.

This question, which is one of such paramount importance to the people of London, would probably be completely set at rest, if a series of borings were put down along a line running from Hertford on the north to Redhill on the south, a distance of less than forty miles. Considering the probable narrowness of the coalfields (that of Belgium averages less than four miles in width) the borings ought to be only a few miles apart, and thus at least ten or twelve borings with a probable average depth of 1000 feet would be necessary. But, of these required borings, four have already been executed, those namely at Ware,

Turnford, Kentish Town, and Tottenham Court Road; and thus only six or eight more borings would be necessary. With the improved methods of working by the diamond rock-drill, these borings could probably be carried to the depth of 1000 feet at the cost of a few thousands of pounds, and this would be a very moderate sum to pay for settling such a highly important question. It is of course possible that only two or three of these borings would be required, and the order in which they should be executed must be in a great measure determined by the results which were obtained by those first put down. Probably it would be well to commence with the sites suggested by Prof. Prestwich and Mr. Godwin-Austen respectively, namely, Croydon or Sydenham, and a point near the North Downs.

The only chance of this line of borings missing the coal-bearing strata would result from the circumstance that the coal-troughs are not continuous, but are, in all probability, like those of Belgium and Northern France, separated by pre-Cretaceous upheaval and denudation, along lines crossing the great axis, into separate long and narrow basins. It is therefore just possible that a boring might reach a point lying between two such basins. It would follow from this that while the Coal-measures, if they exist, would in all probability be found by such a systematic search as we advocate, yet the failure to discover them would not absolutely demonstrate their absence in the whole of the Metropolitan district.

Since it is the people of London who would mainly benefit by the discovery of coal under their city, it is by them that the effort to raise the comparatively moderate sum of money required for such a systematic search as we have advocated must be made. When the magnitude of the interests at stake is remembered, it is surely not too much to hope that, so soon as the people of this city fully realise the importance of the evidence brought forward by geologists, they will be prepared to make the necessary effort to secure the decision of the question in the only way that is practicable, namely, by actual experiment.

Some of those who have recently engaged in this discussion have taken it for granted that the great smoke-pall that too often rests over this city would necessarily be increased by the discovery of coal beneath London. They have therefore stigmatised geologists as "Philistines," resolutely bent on destroying all the little "sweetness and light" left to the unfortunate inhabitants of London. But it is by no means certain that any such effects would follow from the discovery of coal in the metropolitan area. It must be admitted that the beautiful landscapes of our home counties would not be improved if coal-tips, engine-houses, and winding-gear were to rise in all directions about them, but the reduction of coal and gas bills to one-half or one-third of their present amount would, by most London householders, be regarded as a sufficient compensation for such disadvantages. Judging from the character of the coals found in the Bristol and Somerset and the Belgian coalfields, it is probable that while gas- and caking-coals would not be wanting, a great part of the coal under London would prove to be anthracite and hard coals. Every one who has visited the Smoke Abatement Exhibition must be convinced that there is a great future for such varieties of coal. The people of London who are reluctant to alter the construction of their grates so as to adapt them to the use of such coals, at their present prices, might find it well worth their while to do so if those prices were reduced to one-half or one-third of what they are at present.

In this way the discovery of coal under London might lead the way to that general reform in our domestic hearths, which we all desire, but which we find it so difficult to realise; and thus, perhaps, the discovery of coal at a moderate depth beneath us, paradoxical as the suggestion may appear, may lead to the purification of our London atmosphere.

JOHN W. JUDD

THE ENCYCLOPÆDIA BRITANNICA

The Encyclopædia Britannica. Ninth Edition. Vol. XIII. Inf.—Kan. (Edinburgh: A. and C. Black, 1881.)

IT is impossible to refer in detail to all the leading scientific articles in this volume; we can only express our satisfaction of the admirable manner in which the publication keeps to the level of its first promise. We have only space to refer to one or two articles, regretting that those on "Instinct," by Mr. Romanes; "Insectivorous Plants," by Mr. P. Geddes; "Iron," by Dr. Alder Wright; "Kangaroo," by Prof. Flower, and others of equally high mark, can only be referred to.

In Mathematics the *pièce de resistance* is a very carefully digested article upon the *Infinitesimal Calculus*, by Mr. B. Williamson, F.R.S., who has already won his spurs in this field by his two treatises on the Differential and Integral Calculus. In a former notice we expressed ourselves somewhat hesitatingly upon the utility of elaborate articles upon branches of mathematics in a work of this kind, but the "Calculus," we think, lends itself more readily to such treatment than almost any other branch. Certainly the subject, in the hands of Mr. Williamson, is handled in such a way that the student, so far as the text is concerned, will be independent of any of the usual textbooks, and will only require to consult them for exercises to try his hand upon, to test his acquaintance with the principles herein so clearly unfolded and aptly illustrated. The advanced mathematician also will find not only sufficient matter for his purpose, but, what is more serviceable to him, a ready means of reference to the original sources of information. In this respect we cannot speak too highly of the care bestowed on all parts of the two divisions into which the Infinitesimal Calculus bifurcates. The narrative of the contributions of Legendre, Gauss, Abel, and Jacobi to elliptic functions, in the concluding portion of the paper, is an admirably lucid exposition of the relative positions of these great analysts in this department. Mr. Williamson devotes 120 columns to the practical portion of his article: in these he naturally treads on the lines he has pursued in his previous works. He follows the subject of *Envelopes* with a sketch of *Symbolic Methods*, first started by Arbogast, who was succeeded by François, Servois, and in more recent times by Hargreave, Boole, and Crofton. He gives useful reference here also to Hankel and Grassmann, who have treated symbolic methods in a comprehensive manner. Another novel section in this connection

is one on Jacobians, in which the elementary properties of these functions are put before the reader.

In Part II., under Frullani's theorem, reference is made to the recent extensions by Messrs. Elliott and Leudesdorf, and the demonstration by M. Zolotareff, that the remainder in Lagrange's theorem is expressible as a definite integral is given. Our Author was not aware that Mr. Emory McClintock had applied the same mode of demonstration to the similar case of Laplace's theorem, as the number of the *American Journal of Mathematics* (vol. iv., No. 1) has reached this country subsequently to the publication of his article. Due importance is assigned to Definite Integrals and to the hyperbolic functions which now play an important part in investigations.

The last 79 articles are devoted to the subject of elliptic functions, upon which we have written above. The whole of this discussion convinces one how well fitted the writer is to bring out a separate treatise on this branch, and we hope that a rumour which has reached us will soon become an actual fact. We may note the appearance within a very recent date of a new edition of Abel's works. Passing now from the *practical* treatment to the *historical*, which rightly is put in the forefront of the communication, we need not dwell in any detail upon the early history of the subject. That has reached its position of equilibrium, and no stormy winds of controversy are likely to disturb its calm. But we did wonder what position Mr. Williamson would take when he came to discuss the *commercium epistolicum* business. We ourselves had long thought that little could be added to De Morgan's summing-up, still we remembered some strong language which once appeared in our epistolary columns (see vol. v. pp. 62, 81, 121). We need hardly say that Mr. Williamson appears to have gone over all the sources of information which we had ourselves recently examined, and he seems to us to have come to the right solution. We append his summing-up:—

"It is the less necessary now-a-days to enter into the merits of this great quarrel, inasmuch as it has long been agreed upon, by all mathematicians who have examined into the controversy; that Newton and Leibnitz are both justly entitled to be recognised as independent discoverers of the principles of the calculus, and that, while Newton was certainly master of the method of fluxions before Leibnitz discovered his method, yet Leibnitz had several years priority of publication."

A VERY effective article is the one on insects by Mr. R. McLachlan, F.R.S. In it we find condensed into a few pages a very correct and instructive history of this immense class of that subdivision of the animal kingdom now known as the Arthropods. As in most of the classes of the animal kingdom, the limits of the class Insecta are not very sharply defined. In general every one thinks that it is an easy task to define an insect, but to do so in the way that we can define a mammal is not possible with our present knowledge; still a fairly satisfactory diagnosis is here given to us, and the certain small aberrant groups are not altogether overlooked. The insects not only form the largest class of the arthropodous sub-kingdom, but, according to the author, possibly outnumber all the other members of the animal kingdom besides. It seems certain that at the present time there are about 80,000 presumably distinct species of beetles described, and it seems safe to assume that the number of known species of other orders is greater, thus giving a total of about 200,000. But as yet we are only on the threshold of our knowledge of the forms that actually exist in Nature—many enormous groups of living forms being still only very partially studied—so that we may pretty confidently anticipate that some day, not very far distant, the number of known forms will not fall far short, the author writes, of 1,000,000, but we would feel inclined to write instead 500,000. As to the antiquity of the group, indications of it appear in the Devonian series, and become more marked and numerous in the Carboniferous. With few exceptions these are those of insects belonging to orders in which the metamorphoses are incomplete, and there seems no evidence that any anthrophilous insects, such as bees or butterflies, were then in existence. As one ascends the geological scale, insect life gradually develops itself, not becoming however at all abundant until Tertiary times. As to their geographical distribution, they would seem to be everywhere on the earth's surface, the more attractive forms are more often denizens of the tropics, but showy butterflies were found during the late Arctic Expedition almost up to 83° N. lat. They occur on land, in freshwater, in hot springs, in brine, in the deep recesses of vast caverns, on the surface of the ocean, and we may add, are at home under the flow and ebb of its waters all around our own shores. The subjects of the duration of their life, their uses to man, the injuries they directly and indirectly inflict on him, their parasitism, their anatomical structure, the wondrous story of their change of form, these are all ably though briefly handled. The systematic portion of the article, though of necessity condensed into the smallest possible compass, is especially interesting. The sequence of the orders is:—

Metamorphosis complete	Hymenoptera Coleoptera Diptera Lepidoptera Neuroptera
Metamorphosis incomplete	Orthoptera Hemiptera
No metamorphosis	Collembola Thysanura.

The stumbling-block of all systematists has been the Linnean order Neuroptera. The author manages it after the method of Erichson, placing those neuropterous forms with an incomplete metamorphosis as the sub-order Orthoptera. He tucks in the Diptera between the Coleoptera and Lepidoptera, a position we doubt very much that they will consent to occupy, though on the author's views as to the absolute value of metamorphosis in classification, this position might stand. The Mallophaga are without hesitation placed as degraded Pseudo-neuroptera, and the Anopleura as equally degraded Hemiptera, despite what veterans in entomological science (*i.e.* people too old to take in new ideas) may say. But, says Mr. McLachlan, there is a breaking point to elasticity even in ideas of classification; and so he avails himself of an assertion of Sir J. Lubbock, that the Collembola and Thysanura—sprightly things—are scarcely within (we note not without) the pale of true insects. Still fearing that no one else might write about them, that they might be overlooked by the writers of the articles on Crustacea, Arach-

nida, and Myriopoda—as, to speak the truth, was even more than likely—we have a neat little account of them given here. We have written enough to indicate what a freshly-written and interesting though condensed article this is, though on a well-worn theme, and we must be pardoned for so briefly touching on the burning question of classification.

OUR BOOK SHELF

The Year-Book of Pharmacy, and Transactions of the Pharmaceutical Conference. 8vo. Pp. 560. (London: Churchill, 1881.)

THIS year-book is divided into several parts—an introduction, which gives a short account of all that has been done in the year, a section in chemistry, another on materia medica and pharmacy, one on notes and formulæ, another on bibliography, and lastly, the transactions of the British Pharmaceutical Conference at York. A number of short abstracts of interesting papers are included in the work. The excitement caused by the recent case of poisoning by aconitine is likely to make the reader turn first to the papers on this alkaloid. Dr. Wright has furnished his researches on the alkaloids of aconite, the chief being aconitine, which is the active principle of the ordinary monkshood, and the pseud-aconitine, which is the still more deadly alkaloid of the *aconitum ferox*. Powerful as those poisons are, one much more powerful has been obtained by Dr. Langgaard from a species of Japanese aconite. Another paper, of much interest from a forensic point of view, is one on ptomaines, or alkaloidal bodies found in human corpses after exhumation. These are actual poisons, formed in the body by putrefaction, and bearing considerable resemblance, both in their chemical reactions and poisonous effects upon animals, to natural vegetable alkaloids. This subject is one of very great importance, as the condemnation of perfectly innocent persons might result from one of these ptomaines being mistaken for a vegetable poison. There are a number of other researches on the active principles of various plants, remedial and poisonous, but all these yield in interest to those on the synthesis of similar bodies, for the great object of medicine is to cure, not by chance, but with certainty, and towards this object all branches of medical science are as present tending. It was formerly the reproach of medicine that doctors poured drugs of which they knew little into bodies of which they knew less; but now, thanks to experiments made upon animals, instead of upon patients, they now know a good deal both of the bodies they have to treat and the remedies which they are using. Hitherto, however, they have been compelled to use many powerful substances derived from plants, but varying more or less in their constitutional actions. Numbers of these substances have now been examined, and it is probable that before long we shall make them artificially. Prof. Ladenburg has now obtained atropine and hyoscyamine from the nightshade, thorn-apple, henbane, and Duboisia, and has lately got a third principle, hyoscine, from henbane. By decomposing atropine he he obtained tropic acid and tropine, and by recombining these products he again formed atropine. In conjunction with L. Rügheimer, he has now succeeded in making tropic acid synthetically from aceto-phenone, and we now await the synthesis of tropine in order to complete the method of preparing atropine artificially. M. Grimaux has succeeded in converting morphia into codia, another of the alkaloids of opium; and such researches as these, taken in connection with the rapid advance of our knowledge regarding the physiological action of these substances, leads us to hope that the day may not be so far distant when a medical man, wishing to produce a certain effect upon his patient, will no longer have to search haphazard amongst various plants, but will direct the chemist to make the particular body which he requires. We may mention still another paper, less interesting to medical men, but more so to the public at large. Prof. Baeyer succeeded, some years ago, in preparing indigo artificially, but the process was so expensive that it was not likely to be of much practical importance. He has now, however, succeeded in effecting the synthesis in another way, by which he can not only produce the indigo much more cheaply, but can produce it within the fibre of the material to be dyed. The artificial production of alizarin has already wrought a great change in the commercial relations of the South of France, and if indigo be produced synthetically at a lower price than it can be grown, similar alterations may result in some parts of our Indian Empire.

The New Ceylon. Being a sketch of British North Borneo, or Sabah. From official and other sources of information. Written and compiled by Joseph Hatton. (London: Chapman and Hall, 1881.)

IT was hardly to be expected that the new British possession in North Borneo, to which the Queen has recently granted a charter, should long remain without its chronicler. Information at first hand respecting the country is very scarce, but, in the absence of this, Mr. Joseph Hatton in his little volume furnishes us with all that we can expect for the present. The materials placed at his disposal consisted of certain private letters and reports from explorers and the correspondence of the directors of the North Borneo Company. In addition to these he has made use of all that has already been written on Borneo, and the result—"a pioneer volume," he modestly calls it—is such as might have been expected from Mr. Hatton's well-known literary skill. The value of the new colony to science is rather potential than actual. In Labuan and Sarāwak we have only touched the fringes of this vast island; we know but little of its mineral wealth and other natural resources; its geography, geology, fauna, and flora, have never been thoroughly studied. Even Mr. Carl Bock, in the journey described in his recent volume, only crossed a small corner of Borneo. With a settled government, under the British flag, we may expect a great increase in our knowledge of one of the largest and most interesting islands in the world. Mr. Hatton could, had he chosen, have added an interesting account of the early trade of the East India Company to Bandjermassin and other ports in Borneo from the Calendar of State Papers, Colonial Series, edited by Mr. Sainsbury.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Earth-Currents

THE Astronomer Royal desires me to mention, in regard to Mr. W. H. Preece's communication (p. 289) describing an unusually sudden appearance of earth-currents between 10h. and 11h. p.m. on January 19, that our magnetic and earth-current registers both show, throughout the night of January 19, more or less of unusual disturbance, never however very considerable. The greatest deviation occurred in a sudden wave at 10h. 15m., as Mr. Preece describes. From 10h. 50m. until midnight there was general quiet, and the disturbance afterwards was not great.

WILLIAM ELLIS

Royal Observatory, Greenwich, S.E., January 28

In a letter to you last week Mr. W. H. Preece called attention to a sudden appearance of earth-currents on the 19th between 10.15 and 10.20 p.m. G.M.T., traces remaining until 10.50. A magnetic storm was in progress at the time, and had commenced shortly after 4 p.m. The declination magnet moved at first slightly towards the west; but the most rapid movement was towards the east, and commenced at 9.40, attaining its absolute minimum, or greatest E. elongation, at 10.9. It then returned as rapidly westward until 11 p.m., but the absolute westerly maximum was only reached at 6.50 the next morning. The whole range of the declination magnet was 53'·0.

The H.F. magnet was not much disturbed, but the chief irregularities occurred between 9.50 and 10.55.

The V.F. magnet showed more clearly the action of the disturbing force, with a maximum at 7.45 p.m., and a minimum at 3.40 the next morning. The V.F. magnet was tremulous between 10.0 and 10.40 p.m., with a slight minimum at 10.15.

S. J. Perry

Stonyhurst Observatory, Whalley, January 29

The magnetographs at this observatory registered a small magnetic disturbance during the evening and night of January 19, which lasted over an interval of time considerably greater than the earth-currents observed by Mr. Preece.

The magnets were tolerably quiescent until about 4.35 p.m. G.M.T., when the declinometer became disturbed, and the bifilar indicated a gradual diminution of horizontal force, vertical force at the same time increasing. The latter attained its maximum deviation from the average value at about 8.0 p.m., whilst the horizontal intensity indicated its lowest at the same time. The declination after slightly rising, however, continued to diminish, and between 9.30 and 10.15 p.m. it became reduced 20·7 minutes of arc. Between 10.15 and 11.0 it rapidly moved in the contrary direction 19'·0, after which it gradually rose to a position of maximum at 6.50 a.m. on the twentieth, when the needle stood about 10' to the westward of its normal position at that hour. From that point it gradually fell away, and after 11.45 a.m. it only oscillated sligbtly about its usual place.

The movement between 9.30 and 11 p.m. of the bifilar indicated an augmentation of intensity followed by an equally abrupt fall, whilst the vertical-force instrument showed that component of terrestrial magnetism to have been but slightly affected.

As is usual in such cases the abrupt disturbance, or as it is called from the aspect of the curves, the peak, under notice was repeated or echoed on several subsequent days.

On the 20th, about half an hour after midnight very faintly, on the 21st it was stronger, and occurred between 9.20 and 9.50 p.m. On the 22nd between 7.50 and 9.40 p.m., its extent then being 10', and finally on the 23rd, from 9.0 to 10.10 p.m., showing then about the same amount.

The daily weather charts for the 20th report bright aurora seen on the 19th in Scotland and Norway.

Kew Observatory, January 30 G. M. Whipple

Referring to Mr. Preece's letter of the 24th inst., it may be interesting to note that in the Daily Weather Chart for the 20th inst. bright aurora is recorded as having appeared in North-West Europe on the evening of the 19th, the day when the earth-currents were observed.

J. Parnell

Upper Clapton, January 30

Variations in the Sun's Heat

All lovers of science, and more especially those devoted to the study of atmospheric physics, must rejoice to learn that the Government of India has sanctioned Mr. Blanford's proposal to send a properly qualified observer with good instruments to Leh, for the purpose of directly measuring the sun's heating power from day to day.

Meanwhile, as we shall have to wait for another decade before it can be settled with any certainty, how much, and in what way the sun's heat varies, it may be as well to notice the latest and hitherto most valuable indirect evidence, furnished with respect to this question by India.

That country has long been regarded as exceptionally well placed for reflecting in its meteorological phenomena with comparatively little complexity the secular changes in solar radiation, and the only drawback hitherto, has been the lack of good and continuous observations over a large area. This has now been remedied by the excellent organisation introduced by Mr. Blanford, by which the observations made at upwards of 100 regular observatories and more than 350 rainfall stations, are collected and discussed at one central office, and published in one volume. With these it is possible to arrive at average results, in which local variations are eliminated, and which may be accepted with confidence as representing the general conditions over the whole area. In a recent *Pioneer* Prof. Hill gives the following table of the abnormals in the chief meteorological elements for the whole of India during the past few years, which, if indirect evidence is to be trusted, most decidedly favours the hypothesis Prof. Hill and myself have all along regarded as the best working hypothesis, viz. that the sun radiates *most* heat to the earth in the years of *fewest* spots.

Variations of certain Meteorological Elements from their mean Values

Year.	Excess temperature of black bulb thermometer.	Annual mean air temperature.	Mean pressure of water vapour.	Mean proportion of cloudy sky.	Mean annual rainfall.
	°	°	"	Tenths.	"
1875	− ·76	− ·29	− ·004	− ·03	+ 3·66
1876	− ·33	− ·08	− ·017	− ·20	− 4·37
1877	+ ·19	+ ·17	+ ·011	+ ·31	− 2·97
1878	+ ·44	+ ·62	+ ·020	+ ·09	+ 5·66
1879	− ·36	− ·13	− ·014	− ·06	+ 1·97

Prof. Hill appends the following remarks to this table:—

"The radiation, as measured by a thermometer with a blackened bulb, rose gradually until 1878, and then fell off in intensity; the temperature of the air, which seems the next simplest and most direct effect of the sun's heat among those given in the table, also increased until 1878, and then diminished; the vapour tension and cloud—more remote effects—show a similar, but not so closely coincident variation, and finally, the rainfall, the most distant effect of all, appears to lag just about a year behind; for observations made before the commencement of Mr. Blanford's reports for all India indicate that there was a wave of heat in 1873-74, immediately preceding the cold period at the top of the table."

Now while there is no doubt, as Mr. Blanford has recently shown in the *Journal* of the Asiatic Society of Bengal, and elsewhere, that the temperature at the earth's surface is very decidedly influenced by rainfall and cloud, we see from this table that the year of highest temperature was actually that in which *most* rain fell, and Prof Hill has found that the excesses of temperature and rainfall, though not strictly contemporaneous, were most decided in the *same* regions of the country. It is scarcely necessary perhaps to add that the actual sun-spot minimum occurred in the middle of 1878, in order to show the important bearing of these facts on our hypothesis.

Tunbridge Wells, January 24 E. Douglas Archibald

Solar Observations

I inclose two letters which I have recently received from Mr. W. A. Holland, chief officer of the ship *Sarah Bell*, and which I think will interest your readers. It is to be hoped that other observers, whether on land or sea, may have important information to communicate on the subject, which they may be induced to give you for publication.

William Thomson

The University, Glasgow, January 23

Havre, January 10, 1882, *Ship "Sarah Bell"*

Sir,—Being at Sea last November 22 and 23, and our position at noon being lat., 18° 58' S., long. 1° 53' W., and lat. 17° 32' S., long. 3° 39' W. respectively; and while observing the sun's meridian altitude, I noticed a very remarkable dark spot on the sun's disc; it was about one-third of the sun's diameter, and bearing south-east from ☉ centre. On the following day it appeared one-fourth of ☉ diameter, and of bearing west-north-west from centre; by putting down the proper shades of my sextant I could see it very distinctly. I called the captain's attention to the fact at the time, and he says he never saw such a phenomenon in his life; he is a gentleman who has spent his life at sea since the year 1840. Almost at the same time I read from the June number of *Good Words* for 1879 your very valuable article on Terrestrial Magnetism and the Mariner's Compass; but the latter part of the article treating on sun-spots caused me to take this bold step of addressing you, trusting I have not been

over-presumptuous in so doing. I have the honour to be, Sir, your most obedient and humble servant,

W. A. HOLLAND,
Chief Officer of Ship *Sarah Bell*

Havre, January 21, *Ship "Sarah Bell"*

SIR WILLIAM THOMSON,

DEAR SIR,—In reply to your very kind letter of the 18th, I am most confident and very careful in what I have already reported to you. With this exception, that I myself estimated the spot on the sun to be $\frac{1}{6}$ diam., but conferring with the captain he estimated it to be $\frac{1}{5}$ diam., it was purely an estimate of the eye. The first time I observed it I could scarcely believe my own eyes; I immediately and properly adjusted my sextant and observed the sun constantly through the day. The spot appeared to move from the sun's upper limb to the lower limb, and nearly through the sun's centre. The captain and myself most particularly noticed the spot both with and without our telescopes, and we feel quite sure there could not have been any mistake, as I have been in the habit of observing the sun's altitude at the least six times during the day at sea; I add the spot appeared quite black. Weather squally, with a very troubled and confused sea; barometer 29°·93 steady. Trusting my notes may be of some use to you, and that you will hear a more explicit account from other navigators.

W. A. HOLLAND,
Chief Officer *Sarah Bell*, Havre

On the Climate of North Northumberland as Regards its Fitness for Astronomical Observations

IN May, 1880, I became possessed of the telescope, observatory, and astronomical instruments belonging to the late Rev. Henry Cooper Key, M.A., F.R.A.S., and I erected the telescope and observatory at my vicarage at Alnwick, Northumberland. The instrument is a silver-on-glass reflector, the speculum being by Mr. Calver, of Chelmsford, of 18¼ inches aperture; as regards perfection of figure, I believe it cannot be excelled. As a specimen of the work it is capable of performing under the best conditions I may say that last November I measured γ^2 Andromedæ, the components of that exceedingly difficult double star being now separated by only 0″·28 according to the Washington observers. The weather, however, for observational purposes during the last six months of 1880 was so bad here, that I determined to keep a record, as far as possible, of every night in the year 1881, as regards its fitness for astronomical work, and this record I now lay before your readers. I may premise that no fault can be found with the situation of the observatory. It is 250 feet above sea-level, four miles from the sea, there are no mountains or streams sufficiently near to affect the definition, no collieries or manufactories in the immediate neighbourhood; and, if the definition be bad, no cause can be assigned for it but atmospheric disturbance. The following is the record for each month:—

January.—In this months there were 11 nights completely overcast; 4 partially overcast; and 16 clear. I opened the observatory on 5 nights, on 4 of which the definition was very bad, and on 1 bad. On 15 nights there was hard frost accompanied by deep snow.

February.—The nights were: Completely overcast, 22; partially overcast, 6. The definition was on 4 very bad, on 1 bad, and on 1 fair.

March.—Completely overcast, 24; partially overcast, 7. The definition was on 1 very bad, on 1 bad, and on 3 fair. On 2 nights hard frost prevented observations.

April.—Completely overcast, 25; partially overcast, 3; clear, 2. The definition was on 2 very bad, and on 2 nights wind, and on 1 snow prevented observations.

May.—Completely overcast, 10; partially overcast, 9; clear, 12. Definition on 15 nights was very bad, on 1 bad, and on 4 fair. One of the partially clouded nights was too cloudy for observations.

June.—Completely overcast, 14; partially overcast, 2; clear, 14. Definition was on 5 very bad. I was away from home on 9, and engaged on 2 nights.

July.—Completely overcast, 26; partially overcast, 1; clear, 4. Definition was on 1 very bad, on 3 bad, and on 1 I was away from home.

August.—Completely overcast, 25; partially overcast, 3; clear, 3. Definition was on 1 very bad, wind or cloud prevented observations on 4 nights, and on 1 I was away from home.

September.—Completely overcast, 25; partially overcast, 4; clear, 1. Definition was on 4 very bad, and on 1 of the partially clouded nights there was too much cloud for observations.

October.—Completely overcast, 19; partially overcast, 6; clear, 6. Definition was on 4 very bad, on 1 very fine, wind prevented observations on 4 nights, and on 3 I was away from home.

November.—Completely overcast, 13; partially overcast, 5; clear, 12. Definition was on 7 very bad, on 2 bad, on 2 fair, and on 1 very fine. Wind prevented observations on 5 nights.

December.—Completely overcast, 15; partially overcast, 1; clear, 15. Definition was on 6 very bad, and on 4 fair. Wind prevented observations on 3 nights, on 2 I was away from home, and on 1 engaged.

The summary for the year is as follows:—229 nights were completely overcast; 51 were partially so (but of these 4 were too cloudy for observations); and 85 were clear. Thus 132 nights ought to have been available for observations. Of these the definition on 54 was very bad, on 9 bad, on 14 fair, and on 2 very fine. Wind prevented observations on 16 nights, frost and snow combined on 15, on 2 frost alone, and on 1 snow alone. On 16 I was absent from home, and on 3 engaged. Total, 132.

I need hardly point out to your readers that the above record is a somewhat melancholy one for the astronomical observer. Ours is a cloudy sky; but in addition to the great amount of cloud, the atmosphere here is almost perpetually in a state of violent disturbance, so that difficult and delicate telescopic work can very rarely indeed be attempted. Last year there were only two occasions on which I found the definition really fine, and on those it only continued so for a short while. When the stars are visible, they are, as a rule, when looked at through the telescope, seen to be flaring, flashing, fluttering, jumping, twirling, or waving—anything in short rather than remaining steady. This is clearly owing to atmospheric perturbation, because on some very rare occasions the images are still, and the definition is superb. I have not been in the habit of using a telescope for a sufficient length of time to say whether last year was an exceptionally bad one for the North of England, but from what I have heard and read, as well as from nine years' residence here, I am afraid it was not. Perhaps others of your readers can throw a little light on this point.

JEVON J. MUSCHAMP PERRY

St. Paul's Vicarage, Alnwick, January 4

Primitive Traditions as to the Pleiades

MY conclusions as to the Pleiades having been believed to be in early ages the centre of the universe, were not in any way based upon the singular name *Alcyone* for the principal star in that group. I can hardly account for my having so long forgotten the meaning of that name, and its connection with the belief I had found vestiges of, as to the Pleiades being the centre of all things. It is probable that at first I regarded its significance as a mere accident, as Dr. Tylor evidently does, and dismissed it from my mind. The best proof of the widespread traces of the belief in question is to be found in the fact that even since this correspondence took place I have met among the Berbers of Morocco a name for Alcyone, which has precisely the same meaning, and which, they tell me, was given to that star because Paradise is in them, and they are the centre of all things. I have also found that the idea, which, as I stated in my last letter, I have for many years entertained, that those stars were observed by means of openings or passages in temples in early ages, is manifestly well founded.

I find that in the Sahara there are temples or ancient mosques, in which the year is still regulated in this way, there being a tube from the top of the building, very small above and larger below, through which the southing of those stars is observed. I have this not only from natives of the Sahara, but also from a European here who has often heard of the system, though he did not know which were the stars that were observed.

Even the Moors have a vestige of the practice in the singular belief that those stars "rest on the top of the mosques." In the feast of tabernacles, too, which is to be found in the Sahara as well as in far-distant quarters of the globe, the Berber tribes build their temporary tents with a hole at the top, so that the young men who are being instructed may see the Pleiades passing overhead. The Jews here have the same custom, and endeavour to explain it by a curious legend as to Jonah's journey to Nineveh. They forget apparently that Moses wrote a good many years before Jonah was swallowed by the whale.

We can now understand the vestiges in Egypt of a popular belief that the Pleiades are in some way connected with the Great Pyramid, the existence of which was observed with a very natural feeling of surprise by Prof. Piazzi Smyth.

I am convinced that the evidence will be regarded as conclusive that the widespread identities which exist as to the year of the Pleiades and its traditions cannot, as Dr. Tylor assumes apparently, have grown up everywhere from the peculiar shape or position of these stars, but that they must be a heritage, if not from a common ancestor, at least from a common source.

Tangier, January 25 R. G. HALIBURTON

ON THE VEGETABLE FOOD OF THE NEW ZEALANDERS IN PREHISTORIC TIMES

WE are indebted to the now venerable Colenso for a deeply instructive and interesting treatise on the vegetable food of the Maoris in the days before Captain Cook's visit. After a residence of almost half a century among these people, during which he has most assiduously studied their ways, manners, and literature, none could write on any subject touching their history with more assurance. Two gross errors have largely and repeatedly been industriously published concerning these Maori—that they were ignorant of all art, and that they suffered from want of food; and from these assumed facts the deduction has been made that therefore they were when first discovered in a savage and starving state, out of which they have been raised by their intercourse with Europeans. As to the want of food, Mr. Colenso asserts that the natives of the North Island had at this time attained to even a high system of agriculture, and that they were passionately fond of cultivating their grounds.

The ancient New Zealander had plenty of good food, but only such as was to be obtained by labour. For them nature had no lavish gifts—no bread-fruit, no cocoa-nuts, no plantains or bananas—fruits from trees growing almost spontaneously and yielding without toil their delights to mankind. But, on the contrary, the Maoris got their vegetable food by constant industry and hard labour, and this was doubtless in favour of the development of the race, helping the "survival of the fittest." And not only were they great cultivators of the soil, but when first known they were in a state of civilisation far beyond that in which our own forefathers were when Cæsar first led his victorious army among them; indeed Colenso doubts if any ancient people had ever—wanting the knowledge of the metals—advanced so far; and he in a very pleasant manner reminds us that, as Xenophon remarked, "Agriculture is the nursing mother of the arts," and that the agriculturist is bound to the soil; it becomes sacred to him; he is compelled to build houses; unlike the nomad shepherd. Hence comes the town, and then the fortified places of strength, all of which the Maoris had, and none of which their neighbours the Australians and Tasmanians ever dreamt of.

One of the oldest legends of the Maoris treats of their favourite and beneficent hero Maui as catching and binding the sun to prevent his travelling so fast, *so that man might have longer daylight to work in.* In their plantations all worked alike—the chief, his wife, his slave. It was a pleasing sight to see the evenness of their tillage, the regularity of their planting and sowing. In planting the *kumara* and the *taro* the plants were generally set about two feet apart in true quincunx order, with no deviation from a straight line when viewed in any direction; weeds were most rigorously kept down. One peculiarity Colenso calls special attention to, one in which they seemed to differ from all other agricultural races—they never used any kind of manure or fertiliser, unless indeed under the latter denomination might come the fresh annual layers of dry gravel which they spread over their kumara plantations. Their whole inner man seemed to revolt against the idea of employing decaying substances, and when the early missionaries first used such substances in their kitchen gardens, it was brought against them as a charge of high opprobrium; and even in later days, when they saw the beneficial effects arising from the use of manure on potato-growing, they could not get over their prejudices, but chose rather to prepare fresh ground every year, doing this generally by felling and burning the timber on the outskirts of the forest, and with all the extra labour of fencing against pigs.

Their, in every respect, most important food-plant was the Kumara (a variety of the sweet potatoe); the use of it would seem to date from prehistorical times, as their many legends evidently show. In good seasons and soils its yield was plentiful, and it is interesting to remark a fact in connection with this crop, that may bring to the reader's mind the memory of the same thing being done in Ireland with the potatoes. Long before the tubers of the Kumara are of a full size, these are laid under contributions, each plant being visited in turn, and the largest tubers are excavated by means of a small sharp-pointed spade, after which the plant is "earthed" up; these stolen tubers are greatly esteemed. The general digging-up occurs in late autumn, but always before there is any expectancy of frost, and the tubers are carefully sorted. Colenso especially noted the number of well-marked varieties of Kumara, several of which were of great antiquity, and permanent. Over thirty varieties are distinguished, and some old sorts are known to be lost. All the sorts came true, and never varied except as to size. As all of these came down from the cultivation of the tubers, the question at once arises, How were they at first derived? The oldest Maoris never heard of the Kumara flowering, nor did they remember of the introduction of a new sort, but always said they had them of old from their forefathers. In the striking story of the murder of Rangiwhakaoma, translated by Colenso, "a lad, son of Te Aotata, is asked, 'Whither art thou going?' and he replies, 'To look at the Kumara in thy store;' but he is persuaded to descend into the unseen world, in order to see the beautiful Kumara there, which, when he saw the great heaps of, and was lost in admiring them, lo! the whole piled-up stack of Kumara was made to fall suddenly upon him, so that he was immediately killed;" and here the translator adds a practical note to the effect that, in order to let the air in and keep the tubers from mould, they were always packed in great loose heaps, and under cover. There is little doubt that, if the growers of potatoes had adopted some such method of storing their crops as these Maori did with their sweet potatoes, the loss from the potato disease would not have been so great as it very notoriously has been among the stored crop.

The second plant most generally cultivated by the Maori was the *taro*—this was propagated by off-sets; but, from its being a perennial, and always in season, its tubers were not stored, but dug up when wanted. Of this plant over twenty varieties were known, which, like the Kumara, differed greatly in size, quality, and in the colour of the flesh. This tuber played a very important part in many of the higher ceremonial observances—as at the naming of a newly-born child of a chief; at the death of a chief; at the exhumation, which in due time always followed; and also at the visits of welcome strangers.

The third food-plant greatly cultivated was a gourd called *hue*. This noble and highly useful plant was annually raised from seed, and was the only food-plant so propagated by the Maoris, and yet curiously enough of this plant, though yielding seed in great plenty, there is only one species and there are no varieties. As an article of food the fruit was only used when young, and always baked, like the *Kumara* and *taro*, in a common earth oven, and it was eaten like these both hot and cold. It came into use in the summer, before the *Kumara*

crop was ripe. The ripe and dried fruits were used for holding water, oils, and cooked food. Often these vessels were handed down as heirlooms.

First in importance among their wild or uncultured food-plants is the fern stem (*Pteris esculenta*) *amhe*, *roi*, or *marohi*. Good edible fern root is not to be found everywhere, and in some districts it is very scarce. Colenso describes a hill of loose rich earth in the interior, which had been long famed for its fern root, and for the occupancy and use of that hill for digging the root, several battles had been fought. All fern root "diggings" were rigidly preserved. There was a regular set time for digging these rhizomes in the spring and early summer months, when the starch abounded in the cells. The root was never used green. The dried root was slightly soaked in water, washed a little, then beaten, and when properly finished, it would break with the fracture of a good biscuit. It was a very nutritious food, much eaten with fresh fish, and steeped in the sweet luscious juice of the berry-like petals of the *tutu* (*Coriarea ruscifolia*). It is related that the chief Künui, who had been carried off by Commander de Surville in December, 1769, and who died of a broken heart at sea, March 24, 1770, while he ate heartily of all the ship's provisions, pined after the fern root. It is interesting to note that Capt. Cook, on the first voyage, left Doubtless Bay—Kuniu's home—just a day before de Surville entered it. Most of the old traditions, and some of the deliciously quaint old songs of the Maori, sing the praises of this food, even giving it a heavenly origin. It is not without interest to note that the young fronds called *monehu*, just as they made their appearance in spring, were also eaten as asparagus would be with us. This is also, we believe, the custom in Canada.

As in some manner accounting for Cook's view of their condition, Colenso reminds us that Capt. Cook's first visit was at the very period when their *planting* season was just over, and this, the time of the utmost scarceness of *Kumara* and *hue*, that their plantations were far apart and strictly tabooed. Still, Cook says that he saw at Islaga Bay, "from 150 to 200 acres under crop," and that too in a place where, he adds, "We never saw 100 people." Colenso has no excuse for more modern writers, some of whom by long residence, ought to have known better. As to there ever being a "great want of food," the old and intelligent Maoris of the North Island have always denied this, stating that though they had not such good natural gifts as the Europeans—fruits, roots, and vegetables—and though they could only obtain their food by labour, yet that by labour in some form or other, they could obtain enough for all their needs.

SAMUEL SHARP

WE regret to have to announce the death of the well-known geologist and archæologist, Mr. Samuel Sharp. He was the son of Mr. Stephen Sharp of Romsey, Hants, and was born in the year 1815. During his long residence at Stamford, and subsequently in the neighbourhood of Northampton, he made very extensive and varied collections illustrating the geology and archæology of the midland districts. A portion of his fine geological collection was some years ago purchased by the trustees of the British Museum, while another portion has been for a long time placed on exhibition in the Northampton Museum. This latter collection, which very admirably illustrates the geology and palæontology of the district, has, we believe, been left under certain conditions to the town of Northampton, and it will form a valuable nucleus for a local collection, illustrating the natural history of the surrounding district, such as we may hope in time to see rising in all our principal provincial towns. Mr. Sharp was a man of large culture and varied tastes. His papers "On the Oolites of Northamptonshire," read before the Geological Society, are full of most valuable information concerning a district to which he devoted his life-long studies. He wrote a little text-book, "The Rudiments of Geology," which has passed through two editions, and which we have already had occasion to mention favourably in these columns. As an archæologist Mr. Sharp was not less widely known than as a geologist. On all questions of local antiquities he was one of the highest authorities in the Midland district, and many valuable papers relating to these subjects were contributed by him to the local journals. But it was as a numismatist that Mr. Sharp especially distinguished himself. During the last thirty years he by unwearied exertions succeeded in bringing together an unrivalled collection illustrating the productions of the famous Stamford Mint. His valuable memoir on these interesting coins, with it several supplements, was published by the Numismatic Society, and constitutes the best authority on the subject. As a consequence of failing health Mr. Sharp's familiar face has for some years been missed from the geological and archæological societies, in the affairs of which he so long took an active part. His genial manners and hospitable nature endeared him to a large circle of friends, and his loss will be deeply felt. His wide and varied stores of knowledge were always placed at the service of those who sought his aid, and his influence in encouraging the study of his favourite science was productive of much good in the district where he resided. Many a young collector and student of science was indebted to him for useful and friendly advice, and his energies could always be enlisted in aid of any projects which had for their aim the advancement of science, and the diffusion of sound knowledge in his adopted county. Mr. Sharp was a Fellow of the Geological and Numismatic Societies, as well as of the Society of Antiquaries. Some time ago he conducted the members of the Geologists' Association over the district with which he was so well acquainted, explaining to them those geological features which he had himself so carefully worked out. In spite of increasing infirmities and great sufferings Mr. Sharp steadily laboured on in the cause of his favourite sciences, and only a few weeks before his death read several interesting memoirs before the local Antiquarian and Natural History Societies. He died on January 28, in the sixty-eighth year of his age. In him English geology and archæology have lost one of those enthusiastic and disinterested labourers, to whose exertions the progress of these sciences has in the past been so largely due.

THE AURORA [1]

I.

IT has often been remarked that the importance of Arctic exploration is not so much in the geographical discoveries which can now be made during our slow advance towards the North Pole, as in the additions which accrue to physical geography by the observer; quite a new field of observations being opened to the observer during his stay in Arctic regions. The accuracy of this remark is completely confirmed by the new and most important conclusions as to the nature of auroræ which Baron Nordenskjöld has arrived at during the wintering of the *Vega* in the neighbourhood of Behring Strait.

The auroræ observed at the winter quarters of the *Vega* were mostly very feeble and had nothing of the important character they often have in other latitudes. "There are no auroræ, at least none worthy of this name," said one of the *Vega's* crew. But precisely because of their less brilliant character, of their simplicity, so to say, and of their regularity, Nordenskjöld was enabled to arrive at

[1] A. E. Nordenskjöld, "Om norrskenen under *Vegas* öfvervintring vid Berings Sund, 1878-79," in "*Vega* Expeditionen Vetenskapliga Arbeten." The Scientific Work of the *Vega* Expedition, part 1, pp. 401 452.)

certain conclusions as to their origin, which give us quite a new conception of the whole phenomenon of auroræ.

It is well known that auroræ are of two different kinds. The most usual ones in that part of the northern hemisphere which is more or less inhabited, and therefore the best known, show us a luminous arc which consists of rays and beams of light perpendicular to its lower edge. These beams flow towards the zenith, and sometimes they meet together and accumulate in the neighbourhood of this point in the shape of a crown; sometimes they are dissolved into light and bright clouds, or in regular strata of light. The most characteristic feature of these auroræ is the restless motion of light and their continuous changes. Those observed by the Swedish Spitzbergen Expedition in 1872-73, at Mussel Bay, belong to the same kind of auroræ, but with the difference from the European ones that they appeared in the southern or south-eastern part of the sky. They usually began in the shape of an arched band of light at a small height above the southern part of the horizon; soon it rose higher, became less regular and more brilliant, and divided into bundles of light which seemed to have a tendency to meet together in the zenith of the inclination-needle. The beams of light continually changed their place, increasing in number and size, and finally there appeared the well-known beautiful "draperies" of rays.

But besides this kind of auroræ there was sometimes observed another, consisting simply of a luminous halo-like arc, not distributed into rays, and characterised by its feeble brilliancy, as well as by the remarkable quietness of the whole phenomenon. Such were, with one single exception, all the auroræ observed during the wintering of the *Vega* at Kolutchin Bay (67° 5′ N. lat., and 186 37′ E. long.) "Only once," Nordenskjöld says, "on March 29 to 30, did we see some beams of light; but nearly always, as soon as the sky was bright and the faint light of the aurora was not dimmed by sun- or moonlight, we have seen on the north-eastern part of the horizon an arc of equally spread light, the summit of which was 5° to 12° above the horizon. Usually it reached about 10°, and then it spread with a regular curvature for about 45° on both sides of its summit, which

FIG. 1.—The common aurora-arc at the *Vega's* winter quarters.

was situated toward north-north-east (see Fig. 1). Hour after hour, day after day, this arc remained unchanged, varying but insignificantly as to its height, extension, and bearing. Indeed, one might ask if it could not be photographed by an 'exposure' for fifteen minutes." This arc soon received from the *Vega's* crew the name of the "common aurora-arc," which name Nordenskjöld maintains in his description. At Mussel Bay the members of the Swedish expedition also had seen such arcs with regularly spread light, and they had thought that they originated in rays being directed towards the observer. But now Nordenskjöld doubts whether on any occasion the aurora-arc could consist of rays of light. If this explanation were true the arc ought to be more brilliant than the separate rays, but the contrary is the case. Besides, the arcs observed at Mussel Bay were of a far less regular shape and more changeable as to the brilliancy of their different parts, than those observed at the *Vega's* wintering place. In these last there were sometimes observed also streams of light like pulsations which move from one part of the arc to another; and sometimes, but rarely, it happened also that rays of light were cast to a height of 20° or 30°, or even to the zenith.

The "common arc" was often accompanied by one, or several exterior arcs from which it was separated by a dark strip, sometimes crossed by rays of light flowing from one arc to the other. The exterior edge of the aurora-arc was not well defined, as its brilliancy diminished towards the upper edge, spreading a noticeable light on the sky above it. On the contrary the separation line between light and darkness was more definite on the lower edge, so as to convey the impression that the luminous arc reposed on a dark cloud-like basis—the so-called "dark segment." The true name for it would, however, be "the unlighted segment," as it remained dark whilst the sky above the arc was as if covered with a feeble luminous veil. In reality there is no "dark segment" at all. Whilst *usually* the stars were visible through the "dark segment" without any loss of brilliancy, that was not always the case. In the latter case the "dark segment" was in reality a true cloud which simply seemed to have the shape of the aurora-arc; it

seems as if the aurora were cast out of its exterior edge, but in reality there is nothing but a common stratus-cloud, or a low-lying frost-mist, which extends upon a certain part of the horizon, and which has no other connection with the aurora than to diminish its brillancy, whereby the apparent horizon is a little elevated above the true one. The dark segment seemed in this case to be yet darker, and the light seemed to be cast out of the edge of the cloud. "I can maintain with full certitude," Baron Nordenskjöld says, "that the lighted segment of clouds which we saw during the winter of 1878–79 had this origin; and most probably, several luminous mists which we saw during the nights of March 18 and 20, close by our ship, *close by the ice*, were due to the same cause; but I cannot affirm that quite certainly."

The observations and measurements which were made at the *Vega* winter-quarters have led Nordenskjöld to the following conclusions as to the nature of auroræ:—

"Our globe," he says, "even during a minimum aurora year, is adorned with an almost constant crown of light, single, double, or multiple, whose inner edge was usually

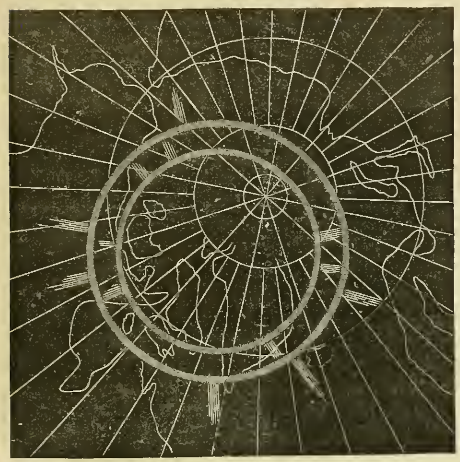


FIG. 2.—Map showing the position of the aurora-glory.

during the winter of 1878–79, at a height of about 0·03 radius of the earth above its surface, whose surface was somewhat *under* the earth's surface, a little north of the magnetic pole, and which, with a diameter of about 0·32 radius of the earth, extends in a plane perpendicular to the earth's radius which passes through the centre of this luminous ring." An idea of this double luminous crown, which Nordenskjöld has named the "aurora-glory," will be conveyed by the drawing, Fig. 2.

Of these two luminous rings of the aurora-glory, the interior, or the "common arc," is the most regular, and it is almost permanent. But it is visible only in such parts of the Arctic regions as are mostly not inhabited by people of European origin; and this circumstance, together with its feeble brilliancy, was the cause of its not having attracted till now the attention it deserves. It is known that even in Sweden the auroræ begin sometimes with the appearance of a halo-like arc, not divided into rays, and which must not be confounded with the ray-auroræ which also often take the shape of a luminous arc. But this regular arc which sometimes is seen in Sweden is not that which was observed at the *Vega's* winter-quarters: it is a second outer ring situated in the same plane as the interior one, but does not have the same regularity nor permanency. As to the ray-auroræ, visible in more southern regions, they are but a particular form of the aurora considered as a whole; they are but emissions of rays from the crowns of light, or aurora glories, which surround the Polar regions of our globe.

The true position of the permanent inner circle of the aurora glory could be easily determined if we had simultaneous measurements made at two distant points. But such observations not being made, Nordenskjöld tries to determine it from measurements made at Kolutchin Bay, admitting the following most probable suppositions:—That the glory is situated in a plane perpendicular to the earth's radius, which passes through its centre; that it is circular, and that its centre is situated somewhere in the neighbourhood of the magnetic pole. Admitting these suppositions, and with the measurements made during the wintering of the *Vega*, Nordenskjöld arrives, by means of calculations, at the conclusion that the centre of the aurora glory does not coincide with the magnetic pole, but is situated about 81° N. latitude, and 80° E. longitude, and, to avoid mistakes, he proposes to give to this pole the name of the "Auroral Pole." The summit of the common aurora arc being visible in the direction of the magnetic North when seen from places situated beyond the projection of the glory on the earth's surface, and in the magnetic South for observers situated within this projection, it is most probable that the centre of the glory is within the ellipse which circumscribes that part of the Arctic regions where the inclination is 90°. But a glance on a map representing the magnetic meridians shows that this hypothesis is far better satisfied when admitting that the aurora-pole is situated at the above-mentioned place, than if we admit that it coincides with the magnetic pole. The sections of the great circles tangential to the magnetic meridians at a distance of 20° to 30° from the magnetic pole, meet the surface of the earth about this same place. But it should be remembered that the section of the luminous crown, as also the position of its centre undergo certain changes. Under ordinary circumstance these changes are slow and within certain narrow limits; but during aurora-storms they are both rapid and wide. In these cases luminous arcs having different centres may appear at once. It is probable that it would not be difficult to determine, from observations made at two distant places, the laws of these changes; but with the measurements we have now at our disposal it is impossible. "We can," Nordenskjöld says, "only point out the main features of the phenomenon, and the above-mentioned figures are intended only to facilitate the understanding of the conception of auroræ which I try to establish." P. K.

(*To be continued.*)

THEODOR SCHWANN

THE death is announced of the distinguished physiologist whose name will be for ever associated with the history of the 'cell-theory.' He was born at Neuss near Dusseldorf in 1810, and was therefore in his seventy-second year. The most important fact in the history of his mental development, is that he came under the influence of the greatest teacher and worker in biological science whom Germany rich in such men, has ever produced, namely Johannes Müller. Schwann was by nine years the junior of his great master, who died whilst in the full tide of active work, at the comparatively early age of fifty-seven. When Schwann was twenty-three years of age, having completed his medical studies, he became Joh. Müller's assistant in the Anatomical Museum of Berlin and remained there for five years. In 1839 he was called to the chair of Anatomy in the Catholic University of Louvain, being then in his twenty-eighth

year. In 1848 he migrated to the chair of Anatomy in the University of Liège, where he remained to the time of his death, having exchanged after a time, the chair of Anatomy for that of Physiology. It is noteworthy that Schwann was a Catholic, which probably had some influence in his selection by De Ram, the ecclesiastical Rector of Louvain University, for the chair which he first occupied, and he appears to have retained the confidence of the Catholic hierarchy in the later years of his life, if we may judge by the fact that an attempt was made by the clergy to procure him as an expert witness in the case of the reputed miraculous "stigmata" of Louise Latour.

Only four years ago—the professors of Liège and the scientific men of Belgium organized a festival to celebrate Schwann's fortieth year of professorship in his adopted country. From all parts of Europe addresses of congratulation flowed in, and public honours of all kinds were showered upon the head of "the founder of the Cell-theory." Schwann was naturally a man of retiring disposition, and simple habits of life. He had visited London twice within the last thirty years, and had not cared to make himself personally known to his colleagues there; he was equally unknown in the laboratories and scientific gatherings of his German fatherland. As he had published very little if anything since 1845,—though actively engaged in his professorial teaching at Liège which was very highly appreciated—Schwann had become to most biologists, one of the great names of the past—a revered historical character. To sit with him in front of a café in the pleasant streets of Louvain, and hear him discourse of the progress of histology and the germ-theory of disease some six years ago, was, for the present writer, a pleasure only less startling than that which could be conferred by one risen from the dead.

His modesty did not prevent Schwann from keenly enjoying the festival offered to him by his colleagues in 1878; and for some time after that event, he was busy in arranging the publication, for circulation among his friends, of a volume which contains an excellent photograph of himself and a complete report of the eulogistic speeches, and a reproduction of the hundred or more addresses from foreign universities and academies which the occasion of his festival called forth.

Among the many honours which Schwann received in 1878 or had previously acquired, may be mentioned the foreign memberships of the Royal Society of London, and of the Academy of Sciences of Vienna. and the Prussian cross 'pour le mérite'; whilst as early as 1845 he received from the Royal Society of London its most coveted decoration, the Copley medal.

Three important pieces of work are due to Theodor Schwann, each of which was the starting point of endless researches carried out by his successors, and to each is still directly and clearly traceable a distinct and vastly important line of investigation which, up to the present day, is being pursued with ever increasing activity. The first of these consists in his observations and reflections relative to the cell-structure of organisms; the second is his discovery of the organic nature of yeast, of the yeast plant as the cause of alcoholic fermentation, and of organisms as the cause of putrefaction in general; the third is his investigation of the laws of muscular contraction which is declared by the competent authority of Du Bois Reymond to have been "the first occasion on which an eminently vital force was examined as a physical force and the laws of its action expressed mathematically in numbers."

Schwann's name is very generally known only in connection with his "microscopical researches into the accordance in the structure and growth of animals and plants," and as it seems to us somewhat erroneously, his merit is apt to be associated prominently or even exclusively with the history of Histology. In reality Schwann's merit as an anatomical histologist is comparatively a minor affair; the striking features in his *Microscopical Researches* are his breadth of view and the physiological generalizations which really constitute his cell-theory. Schwann started the conception of a physiology (*i.e.* a truly chemico-physical physiology) of the cell and without using the word "protoplasm" laid down in principle all that it implies. He established in so many words the difference between "crystalloids" and "colloids," and attributed the peculiar growth of cells to the capacity possessed by their substance of imbibing liquids; and further suggested that a peculiar molecular arrangement may exist in those colloid units comparable to the molecular structure of true crystals.

Both in animals and in plants "cells" had been recognized as a very general feature of their structure, previously to 1838. Comparisons had been made between the "cells" known to form plant-tissues and the "cells" seen in some animal tissues. Johannes Müller had especially compared the cells of notochordal tissue to the cells of vegetable parenchyma and had led Schwann to give attention to this matter. But as yet there had been no notion that the cells of plants were the *same* kind of things as the cells discovered in animals. Mirbel followed by Schleiden now propounded the view that *all* vegetable tissues are formed of cells more or less modified, and are produced by the developmental transformation of a primitive cellular tissue. This conception, as Schwann states, fired his imagination and the hypothesis occurred (in 1837) to him that animal and vegetable cells are of identical character, the structural and physiological units of organic nature, and that not only vegetable tissues but animal tissues also are ultimately to be traced to cells. He proceeded most laboriously to test his hypothesis by searching for cell-structure in every kind of animal tissue upon which he could bring his microscope to bear. He confirmed his hypothesis and not only that, but he made a number of important discoveries, in detail, as to the structure of animal tissues, and published his "Researches" in 1839.

The merit of transferring the botanical doctrine of cell-structure to animals and of thus raising it from special to universal application, was undeniably a great one and belongs to Schwann, as does also the merit of having securely established this doctrine by new observations—a task which speculative naturalists are often, in similar cases, disposed to leave to the care of their disciples.

But it is not this *morphological* generalization as to cell-structure which is Schwann's greatest claim to our regard. That is to be found rather in his *physiological* cell-theory, in the masterly chapter in which he lays down the view that the physiological processes occurring in these units called cells are, when summed up, that which we call "life," and *that these processes may be traced to mechanical* (that is to physico-chemical) *causes*. The later "protoplasm-theory" is scarcely an advance upon Schwann, as compared with the great gap which separates his "cellular physiology" from all that preceded it.[1]

[1] The following extracts from Schwann's last chapter of his "Researches," entitled "The Theory of Cells," cannot fail to interest and even astonish the reader when he reflects that they were written five-and-forty years ago, when the doctrine of evolution was almost if not entirely ignored by naturalists. It is also instructive to note that the man who held these views and proclaimed them was an orthodox catholic, and was not considered unfit to be called from Berlin to a Belgian university by the clergy, nor subsequently did a Liberal Ministry fear to promote him from the Chair of Louvain to that of Liège.

(A) "In physics all those suggestions which were suggested by a teleological view of nature, such as 'horror vacui,' and the like, have long been discarded. But in animated nature, adaptation—individual adaptation—to a purpose, is so prominently marked, that it is difficult to reject all teleological explanations. Meanwhile it must be remembered that such explanations which explain at once all and nothing, can be but the last resource, when no other view can possibly be adopted. In the case of organised bodies there is no such necessity for admitting the teleological view. The adaptation to a purpose which is characteristic of organised bodies differs only in degree from what is apparent also in the inorganic part of nature; and the explanation that organised bodies are developed, like all the phenomena of inorganic nature, by the operation of

It is seldom given to one man to fully establish so vast an innovation in scientific doctrine as is the "cell-theory" in its complete form. Schwann had not this good fortune. His position may be indicated in his own words taken from his "Microscopical Researches" published in Berlin in 1839 immediately before his departure for the chair at Louvain. He says: "The elementary parts of all tissues are formed of cells in an analagous though very diversified manner, so that it may be asserted, *that there is one universal principle of development for the elementary parts of organisms however different, and that this principle is the formation of cells.* This is the chief result of the foregoing observations." So far Schwann has only been confirmed and established by all succeeding observers. But when he came to attempt to explain the formation of the cells themselves, Schwann signally failed. He proceeds: "A structureless substance is present in the first instance, which lies either around or in the interior of cells already existing, and cells are formed in it in accordance with certain laws."

Schwann put forward the notion that cells are produced by a sort of aggregative process in a structureless mother-substance; he did not recognize any more than his botanical contemporaries the universal origin of cells by the division of pre-existing cells, although he very fully and correctly identified the animal ovum with a single cell, its "germinal vesicle" with the cell-nucleus and the "germinal spot" with the cell-nucleouls discovered by him. The enunciation of the doctrine "omnis cellula e cellulâ" was reserved for later workers. Von Mohl in plants, and Kölliker and Remak in the cephalopods and vertebrates respectively, made observations on cell-division which have contributed more than any others to the filling out of Schwann's cell-theory by the true doctrine of cell-genesis. It may in truth be said that up to the present day a large part of the progress in both vegetable and animal histology since Schwann's time, has consisted in the demonstration in case after case of the erroneous nature of his doctrine of the free formation of cells.

It is not an easy matter to estimate Schwann's influence in the history of that exact experimental physiology, which his researches on muscular contraction inaugurated. It is sufficient to point to the enormous development of that branch of enquiry within his lifetime, and to insist upon the wide range of capacity (however much we may recognise in its activity the influence of the great Johannes Müller) which enabled one and the same man to establish the generalisation known as the cell-theory, and, at the same time, to make the first exact measurements of the operation of forces in a living body, by the methods and instruments proper to the physicist.

blind laws, coeval with the existence of matter itself, cannot be rejected as impossible. Reason certainly requires some ground for such adaptation, but for her it is sufficient to assume that matter, with the powers inherent in it, owes its existence to a rational Being. Once established and preserved in their integrity, these powers may, in accordance with their immutable laws of blind necessity, very well produce combinations, which manifest, even in a high degree, individual adaptation to a purpose. If, however, rational power interposes after creation merely to sustain, and not as an immediately active agent *then it may, so far as natural science is concerned, be entirely excluded from consideration in relation to the creation.*"

(B) The first development of the many forms of organised bodies—the progressive formation of organic nature indicated by geology—is also much more difficult to understand according to the teleological than the physical view.

(C) "An explanation of the teleological kind is only admissible where the physical can be shown to be impossible. Assuredly it conduces more directly to the object of science to at least make the effort to obtain a physical explanation. And I would repeat that when speaking of a physical explanation of organic phenomena, it is not necessary to understand an explanation by *known* physical powers, such, for instance, as that universal refuge, electricity, and the like; but an explanation by means of forces which operate *like* the physical forces, in accordance with the strict laws of blind necessity, whether they are also to be found in organic nature or not.

"We set out, therefore, with the supposition that *an organised body is not produced by a fundamental power which is guided in its operation by a definite idea*, but is developed, according to blind laws of necessity, by powers which, like those of inorganic nature, are established by the very existence of matter."

Schwann's merit in relation to the doctrine of organisms as the cause of putrefaction and of fermentation, requires to be more fully noticed since the history of recent research in these subjects has been such as to place a French chemist, M. Pasteur, before the scientific world in the position which truly belongs to Schwann. The latter appears never to have followed up the brilliant experiments by which he demonstrated that putrefactive and fermentative processes depend upon the access of organic germs to the fluids in which those processes occur. But in his "Microscopic Researches" there is an important note on "the theory of fermentation set forth by Cagniard-Latour and myself," in which the yeast-cell is described as an elementary organism, and its activities are discussed as "the simplest representation of the process which is repeated in each cell of the living body." It is a remarkable fact that although Schwann communicated his "cell-theory" to the Academy of Sciences of Paris in 1838, and although his experiments on putrefaction and fermentation form the basis of the observations which have since been conducted with so much approval by M. Pasteur, who has received ample recognition from that body, yet no honour of any kind was ever conferred upon Schwann by the French Academy of Sciences. Even in his old age, at the celebration in 1878, France stood last of all European countries—behind even Switzerland, Holland, and Spain—in the expression of appreciation of, and interest in Schwann's work, as shown by the printed collection of addresses and letters.

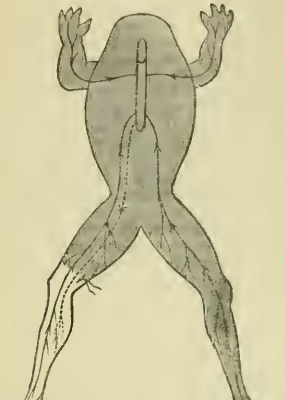
It seems therefore not unfitting to state precisely on the present occasion that the discovery of the relation of those ubiquitous organisms, the Bacteriaceæ, to putrefaction (and thus indirectly the immense benefits obtained by our Lister's treatment of wounds) is due in the first place to Theodor Schwann, who also discovered the organic origin of alcoholic fermentation, and devised and carried to a high pitch of perfection those methods of experimenting upon this subject which have since been amplified and extended by M. Pasteur.

E. RAY LANKESTER

WOORARA

NOTWITHSTANDING the deference with which every statement that Claud Bernard has made ought to be treated, it seems probable that he was mistaken in his ideas regarding the effect of woorara on sensory nerves. The indications of sensibility under the action of woorara are afforded by the limb of a frog to which the poison has not had access, so that the endings of the motor nerves in it are not paralysed. On pinching a portion of the skin anywhere in such an animal, even on the poisoned leg, it is noticed that movement takes place only on the unpoisoned one, while all the poisoned parts remain perfectly limp and motionless. But this movement, while it might indicate pain, does not necessarily do so, and may only indicate simple reflex action. The difference between these two conditions, in which the movement is alike, is that which exists between the effect of tickling the sole of the foot in man with a feather and running a pin into it. In both cases the foot would be drawn up, perhaps even more so with the feather than with the pin, but the pin would cause pain, and the feather would not. The movement of the frog's leg in woorara poisoning much resembles that caused by the feather, for it will occur as readily, or more so, if the brain has been removed. We know that in cases where the spinal cord has been broken by accident in man reflex occurs in the legs quite readily, but of this the patient himself is utterly unconscious excepting by seeing the movements in the same way as a bystander. Increased movement, therefore, in the curarised frog, instead of indicating increased sensibility to pain, may only indicate increased irritability of the

spinal cord and in all probability does so. The same arguments which would prove that woorara increases the susceptibility to pain prove also that morphia does so, for in small doses morphia also increases the movement of the leg of the frog in the same way as woorara; but we know perfectly well from observation in man that morphia does not increase pain even in small doses, and that a large dose completely abolishes it. There can be little doubt that large doses of woorara also abolish sensibility as well as motion, for after the poison has acted awhile, the movements, even in the protected leg, become less and less, showing that the spinal cord has been paralysed; but before this take place, the sensory nerves themselves are paralysed by the poison, as was first shown by Schiff, the correctness of whose experiments has been since confirmed. The mode of experiment will be better understood by reference to the accompanying diagram representing a frog, in which the artery going to one leg has been tied so as to protect it from the influence of the poison. This leg has been left unshaded, but all the



poisoned parts of the body are shaded. At first, pinching in any part of the body, whether poisoned or not, will induce movement in the non-poisoned leg, but after a little they do not, while pinching of the skin of the unpoisoned leg below the point of ligature will cause movements. This is most strikingly seen when the skin is pinched, first just above the ligature, and afterwards just below it. The pinch above the ligature produces no effect; the pinch below it produces movement. In the former case the sensory nerves have been poisoned by the woorara; in the latter case they have not. This experiment shows clearly that the ends of the sensory nerves are also paralysed by woorara like the ends of the motor nerves, although they are not so quickly affected, for a reference to the diagram will show that the trunks of both motor and sensory nerves and the spinal cord have been equally exposed to the poison, and that the only difference between the skin just above the ligature and just below it is that the ends of the sensory nerves above it have been poisoned, and those below it have not been poisoned. It is therefore almost certain that woorara in large doses diminishes, and finally abolishes all susceptibility to pain, as well as all power of motion, and that it may be looked upon as an anæsthetic, although not so powerful as chloroform, ether, or morphia.

NOTES

The American Association for the Advancement of Science will hold its thirty-first annual meeting in Montreal during the week beginning Wednesday, August 23, 1882, under the presidency of J. W. Dawson, LL.D., F.R.S. A large attendance is expected from the United States and Canada, and it is hoped that there will be a good number of visitors from the British Islands and Continental Europe. The new Redpath Museum of the University, then to be opened, will contain remarkable collections, in part gathered for the occasion, illustrating American Geology and Archæology. The Allan and Dominion lines of steamers have placed at the disposal of the Local Committee a considerable number of passages from Liverpool to Quebec and back, at much reduced rates, and arrangements will be made for entertaining private visitors. Circulars, giving full particulars, will soon be issued, but meanwhile it is requested that any persons proposing to avail themselves of the occasion will communicate as soon as possible with Dr. T. Sterry Hunt, Montreal, Canada.

A letter has been received by one of the local secretaries of the British Association, intimating that Prince Leopold (Duke of Albany) had consented to accept the position of President of the Local Committee for the annual meeting of the British Association to be held at Southampton in the ensuing autumn. It is understood that the Earl of Carnarvon, the Bishop of Winchester, and Lord Northbrook, have agreed to act as Vice-Presidents. Answers have not yet been received from many other noblemen and gentlemen to whom similar invitations have been given.

What a treasury of information the U.S. Census is compared with our own meagre enumeration. We have received, for example, five maps, with accompanying statistics, under the title of "Forestry Bulletin," showing the pine supply of Texas, Florida, Alabama, Mississippi, and Minnesota; doubtless the series will be completed. These maps not only show the area under pines, but also the distribution of the different species of pines, while, among other useful information, the text gives the number of feet standing.

We can only this week announce the death of Sir Robert Christison; next week we shall give some particulars of his career.

The Royal Society of New South Wales offers a prize for the best communication, containin g the results of original research or observation, upon each of the following subjects:—Series I. (to be sent in not later than September 30, 1882). No. 1. On the Aborigines of New South Wales, 25*l.* No. 2. On the treatment of auriferous pyrites, 25*l.* No. 3. On the forage plants indigenous to New South Wales, 25*l.* No. 4. On the influence of the Australian climates and pastures upon the growth of wool, 25*l.* Series II. (to be sent in not later than August 31, 1883). No. 5. On the chemistry of the Australian gums and resins, 25*l.* No. 6. On water supply in the *interior* of New South Wales, 25*l.* No. 7. On the embryology and development of the marsupials, 25*l.* No. 8. On the Infusoria peculiar to Australia, 25*l.* The competition is in no way confined to members of the Society, nor to residents in Australia, but is open to all without any restriction whatever, excepting that a prize will not be awarded to a member of the Council for the time being; neither will an award be made for a mere compilation, however meritorious in its way—the communication to be successful must be either wholly or in part the result of original observation or research on the part of the contributor. The Society is fully sensible that the money value of the prize will not repay an investigator for the expenditure of his time and labour, but it is hoped that the honour will be regarded as a sufficient inducement and reward. The successful papers will be published in the Society's Annual Volume. Fifty reprint copies will be furnished to the author free of expense. It is the intention of the Society to offer additional prizes should this first attempt to encourage original

scientific investigation be reasonably successful. The Society deserves the highest credit for the enterprise, and we hope they will be encouraged to continue it.

It was lately announced that a German in Russia, Herr Dittmar, had found a way of solidifying petroleum, which would be of great commercial advantage. The method (we now learn from *Deut. Ind. Zeit.*) consists in heating petroleum in a still with 2, or at most 3, per cent. of soap. At first there is a great deal of foam; and at 100° the whole mass suddenly becomes like wax. For liquefaction afterwards vinegar is used. So far as yet apears, the invention is not applicable to raw naphtha. The distilled oils at Baku (on the Caspian) should be solidified, transported, and then submitted to further distillation. A lively discussion on the subject recently took place at the Russian Technical Society in St. Petersburg, and some objections raised by Prof. Wilchinski were not, it is said, adequately met by the inventor. It was urged, *inter alia*, that the solidifying did not wholly do away with leakage. When a piece of the solid petroleum is laid on blotting-paper, the latter absorbs some of the petroleum, and the solid piece loses weight. The same occurs with wood, and the proposed wooden cases, saturated during transport, might give off vapours which, mixing with air, would form explosive mixtures. If cases impermeable by petroleum were used instead, the advantage of the cheaper chests would fall away. Further, the consumption of soap (not a very cheap material) is considerable; thus 100,000 cwt. of petroleum would take 2000 cwt. of soap. The fatty matter need not indeed be lost, but it would be lost for the naphtha district, as the carriage back would not pay. Further, the solid petroleum could not be brought into the houses, but would require large central liquefying works, whence the liquid would be carried in vessels. Herr Ditmar's figures, showing a great advantage in the cost of transport of solid petroleum, were vigorously debated, and it was pointed out that the unloading of the chests was disadvantageous compared with the simple pumping from tanks.

Does the resistance of a gas to the motion of a solid body in it vary with the temperature when the density of the gas is kept perfectly constant? To this a negative answer has been given lately by M. Hirn, as the result of some ingenious experiments; and the deduction follows that the ideas at the base of the kinetic theory of gases must be given up, for according to that theory (Clausius) the resistance must vary, other things equal, in the direct ratio of the square root of the absolute temperature. M. Hirn, indeed, affirms "that the pressure and temperature of gases are not constituted by movements, of whatever kind, of material atoms." His experiments were made with a pendulum arrangement in a large globular vessel of glass, the pendulum consisting of a rectangular glass plate suspended by a steel wire, which passed up through a stopper of vulcanised caoutchouc. The temperature was varied between 11° and 50° C. In their reports on the memoir to the Belgian Academy, MM. Folie, Van der Mensbrugghe, and Melsens, while recognising the high merit of M. Hirn's researches, are still not prepared to accept his results. It is pointed out, *inter alia*, that the range of temperature is too limited. In M. Clausius' hypothesis, moreover, the law of resistance relates to *rectilinear* motion of a disc in an *indefinite* fluid, whereas the author experiments with *alternating* motion within a vessel *hermetically closed*. One of the reporters thinks the vessel should have been carefully weighed before and after the experiments. Once more the experiments of Meyer, Stefan, &c., on internal friction of gases have proved an incontestable influence of temperature. M. Hirn, in his memoir, indicates the far-reaching nature of his results, and their bearings on metaphysical questions. A *résumé* of this part of his argument is given by M. Melsens in his report (*Bull. Belg. Ac.*, Nos. 9 and 10).

It is just fifty years since the first number of *Chambers's Journal* was published, and its founder, Dr. Wm. Chambers, gives in the number for January some interesting reminiscences of its and his own long career. He has reason to be proud of both; his journal has done much to spread sound and healthy knowledge, and all along in its pages science has had its place. The house of which Dr. Chambers is the venerable head has through its many publications, a large proportion of which are scientific, had no inconsiderable share in fostering and promoting the now widespread desire for thorough popular education.

It is interesting to observe that the nobles of Japan, whom superficial writers are accustomed to regard as an effete and useless class, are taking up with much vigour the question of education in Western knowledge among members of their own body. A few years ago a school for the sons of *Kwasoku* (the old *daimiô* class) was opened in Tokio. All the funds necessary for a large and handsome building were contributed by the nobles themselves, and education in Western methods by trained native and foreign teachers was commenced. A recent decree of the Mikado has ordered the establishment of a Senate and House of Representatives, and it is believed that the hereditary nobility, or a certain number of them will have seats in the upper house. In order to render them fit for these new duties, it has now been decided that all pupils graduating in the nobles' school above mentioned shall be sent abroad to study in Europe or America. It may be added that the great majority of the Japanese students in this and other foreign countries are now studying wholly at their own expense. This interesting fact would go to show that the thirst for Western knowledge in Japan is widespread; otherwise the relations of these young men would not spend the comparatively large sums required for their maintenance abroad.

The latest information from the East shows the existence of wide-spread seismic disturbance of an unusual kind. Details of a destructive earthquake in the Chinese province of Kansuh have been received. At one place (Kanchou) 42 persons were killed and 27 injured. One hundred houses also were destroyed, and 120 animals killed. At Chiebichou the damage was much greater, 347 persons were either killed or injured, and 300 animals killed. As frequently occurs on these occasions, the disturbance was followed by an inundation which caused such destruction that the Emperor has been petitioned to remit all taxes and dispense charity. From the Philippine islands we receive news of a violent eruption of the volcano of Mayon, which has ruined many cocoa-nut plantations and caused much alarm. The whole island of Ceylon has also been visited by an earthquake, which, however, did little damage.

We are glad to observe that the King of Siam is vigorously extending education throughout his territory. He has recently erected two new schools in Bankok. At one of these, where English is taught, a number of his Majesty's sons and brothers are among the pupils. At the other school only the vernacular is taught.

As we anticipated in Nature a short time ago, the Chinese telegraph line have been thrown open to the public, but no one could have been prepared for the manner in which this was done. The authorities have taken into consideration the fact that telegraphic communication is new in China, and that its advantages will make their way slowly among the people at first unless some vigorous steps were taken to make them known. They have accordingly decided to give the public free use of the lines for one month. This bold and wise measure will, we doubt not, be fully justified by the result.

A Roumanian engineer, M. Theodorescu, has invented a submarine ship, before which all similar inventions are said to

pale. This ship, according to the statement of the inventor, can be guided for twelve hours completely under water, the depth of immersion varying between 100 and 300 feet at the option of the commander. Upon the surface the ship can be managed like any other vessel, its rate of speed, however, being less than that of ordinary steamers. The diving is done by means of screws, vertically, and can be accomplished suddenly or gradually. In the same manner the ship can be made to emerge from the water. When the vessel is under water, enough light is supplied to enable those on board to see any obstacle 130 feet ahead, and to regulate the ship's motion accordingly. The air supplied to the vessel is said to suffice for the whole crew for about twelve to fourteen hours. In case of need the air reservoir can be filled again, even under water, by means of telescopic tubes sent up to the surface. The progress of the vessel, as well as the diving, are said to be absolutely noiseless. We give all these details from the inventor's statement with due reserve, but should they prove true, the invention would be likely to prove a highly valuable one even for peaceable objects, apart from its great utility in naval warfare.

It is announced that, at the instance of the Marquis of Lorne, the initiatory steps have been taken for the establishment of an academy of eminent literary and scientific men in Canada, after the plan of the Assembly of the Immortals in France. The proposed body is to be composed of six sections, representing English and French letters, history and archæology, and the mathematical, physical, geological, and biological sciences. It is probable that there will be ten or twelve members in each section. Dr. Dawson is spoken of as the first president.

The Boston Society of Natural History have published in a separate form various papers on the Palæolithic implements of the valley of the Delaware.

Prof. Kirchhoff, of Hallé-a-S., announced at the last meeting of the Saxo-Thuringian "Verein für Erdkunde" that the second German Geographical Congress will take place at Halle during the current year. A committee has been formed.

On the day following his resignation as Minister M. Paul Bert was nominated president of the Société de Biology, filling the room which had been vacated by the death of Claude Bernard.

A slight shock of earthquake was noticed at Agram on January 9 at 2.29 a.m.

With regard to the *Jeannette* expedition the latest news received at St. Petersburg, January 28, from Irkutsk, states that Mr. Melville has started for the mouth of the River Lena to resume the search for Lieut. De Long. The search will be carried on with the utmost vigour with the aid of the natives. The supply of provisions is plentiful, so that if necessary the search may be prolonged until far into the summer. Mr. Melville will be accompanied on his expedition by the captain of the steamer *Lena*.

At the meeting of the Geographical Society on February 13 Sir Richard Temple, Bart., G.C.S.I., formerly Governor of Bombay, will deliver a lecture on the Geography of the Birthplace and Cradle of the Mahratta power in Western India. The lecture will be illustrated by the author's own sketches, which have been enlarged for the occasion by his brother, Lieut G. T. Temple, R.N.

From the *Compte Rendu des Séances*, just issued by the French Geographical Society, we learn that at their next meeting on February 3, some interesting letters will be read, including one from Dr. Crevaux, who is about to explore the sources of the Pilcomayo in the Bolivian Andes, and afterwards descend the river to its mouth. A paper will also be read by Col. Veniukoff on the unexplored parts of Asia.

The Moscow Society of Naturalists have appointed a special Commission to inquire into the influence of the decrease of forests on rivers and streams. This Society intend to celebrate, on May 14 next, the fiftieth anniversary of the doctorate of their vice-president, M. Charles Renard, who has for forty-two years rendered eminent service to the Society as well as to science.

An important meeting of the Executive Committee of the Parkes Museum was held on Friday, Prof. Berkeley Hill in the chair. The Curator, Mr. Mark H. Judge, as Secretary of the recent International Medical and Sanitary Exhibition, presented the final report of the Exhibition Committee, which, after giving a detailed account of the origin and success of the undertaking, concluded as follows:—"The work for which the Exhibition Committee were appointed having now come to an end, they have the satisfaction of handing over to the Executive Committee of the Museum the sum of 933*l*. 11*s*., together with furniture and fittings to the value of 100*l*., while contributions to the Guarantee Fund to the amount of 86*l*. 19*s*. have been transferred to the Parkes Museum Building Fund, making the financial result of their labours a profit to the Parkes Museum of 1,120*l*." The Honorary Secretary, Dr. G. V. Poore, read a communication from the Council of University College, in which that body agreed, with some modifications, to proposals which had been made in behalf of the Museum to the Council of the College in reference to the erection of a building for the Museum. After a long discussion the modifications suggested by the Council of University College were accepted, and it was resolved that steps should be taken to obtain the funds necessary for carrying out the scheme, which embraces (1) the building of an addition to the north wing of the College for the purposes of the Museum; (2) an endowment for the maintenance and management of the Museum; (3) the Museum to be opened free to the public and to be placed on a somewhat similar footing to the North London Hospital, *i.e.* to be autonomous, with due representation of the Council of University College on the Executive Committee of the Museum. It is estimated that 30,000*l*. is the sum that will be required thus permanently to establish the Museum as a national institution. Towards this Mr. Thomas Twining of Twickenham, had written to say that he would subscribe the sum of 100*l*. if one hundred promises of a similar amount were obtained. Promises of subscriptions may be sent to the Curator at the Parkes Museum, University College, Gower Street. Subscriptions may be paid to the account of the Parkes Museum at the Union Bank, Argyl Place, Regent Street.

The additions to the Zoological Society's Gardens during the past week include a Toque Monkey (*Macacus pileatus* ♂) from Ceylon, presented by Mrs. Evans; an Azara's Fox (*Canis azaræ*) from South America, presented by Mr. Owen E. Grant; an Indian Vulture (*Gyps bengalensis*) from India, presented by Capt. Th. Leportier; a Chimpanzee (*Anthropopithecus troglodytes* ♀) from West Africa, deposited.

OUR ASTRONOMICAL COLUMN

The Observatory of Harvard College, U.S.—The Annual Report of the proceedings of this Observatory, presented to the visiting Committee in November last by the present zealous director, Prof. Pickering, has been issued. Aided by the subscription raised in 1878 for the support of the Observatory for five years, the director has been enabled to keep the establishment in great activity, and his Report will be a gratifying proof that the funds placed so liberally by subscribers at his disposal are being dispensed in a manner that must prove of great advantage to the progress of astronomical research. Three instruments the equatorial of 15-inches aperture, the meridian circle, and the meridian photometer, have been kept in active

work. With the former, sixty-four eclipses of Jupiter's satellites were observed photometrically, an improvement having been introduced by which the number of settings is largely increased. A single observer, it was found, could make but three settings in a minute, or one in twenty seconds. With an assistant to record, the time is reduced to about nine seconds, while by the employment of two assistants, one of whom reads the photometer circle, while the other records and observes the time by the chronometer, the time is reduced to five seconds. It is probable that, as the observer does not remove his eye from the eyepiece, the accuracy of the observations is increased, and the satellite followed nearer to the point of disappearance. The search for objects having singular spectra, which only admits of being carried on in perfectly clear, moonless nights, had been much interrupted by other current work. The most notable result was the discovery of the peculiar spectrum of the star Lalande 13412, a seventh magnitude; two of the lines appear to be coincident with two in the spectrum of the great comet of 1881, as described by Dr. Konkoly; "accordingly, while other comets have a spectrum identical with that of the stars of Secchi's fourth type, this comet contains a substance as yet unknown, which one star only is as yet known to contain." The star L^2 Puppis was found to have a banded spectrum; its declination is more than forty-four degrees south of the equator, and at the time of Prof. Pickering's examination it was less than two degrees above the horizon. Its variability was pointed out by Dr. Gould (*Uranometria Argentina*, p. 279); he inferred a period of about 135 days; maxima occurred in 1874 on Feb. 8 and June 25; the star is stated to be red in all its stages and remarkably so about minimum, limits of variation 3·6 and 6·3. The position for 1875·0 is in R.A. 7h. 9m. 43s., N.P.D. 134° 26′. 2. The spectra of all the stars north of − 40°, marked as red or coloured in Dr. Gould's work have been examined at Harvard College, no peculiarity of spectrum being detected in the majority. Algol and the star D.M. 81°, 25 were assiduously studied photometrically. The meridian-circle had been in use on 250 days. The work originally proposed for the meridian-photometer, viz., the measuring on three nights the light of each of the naked eye stars visible in the latitude of the Observatory, was essentially completed on August 25, 1881, but it is intended to continue the observations for another year, as the necessary delay in reduction and publication will not be greatly increased thereby. With the view to a more complete comparison of the photometric observations with those made by the naked eye, which the *Uranometria Argentina* affords the means of doing as far as 10° north, all the stars in the *Atlas Cœlestis Novus* of Heis north of the equator and brighter than the sixth magnitude, are being measured by the eye, aided by an opera-glass when necessary. It is intended that each star shall be measured by three observers, who are to compare it with two stars in the vicinity of the pole, one a little brighter, the other a little fainter; the interval between the two stars is supposed to be divided into ten parts, and the brightness of the star under comparison is estimated on terms of this interval. Prof. Pickering mentions that out of about nine thousand comparisons required for this work, nearly a quarter have been already made.

Vol. xiii. of the "Annals" now in process of publication will contain results of work with the large equatorial, under the direction of the late Prof. Winlock, and micrometrical measures up to the present time. These include measurements of double stars, observations of nebulæ and their spectra, satellites of Saturn, Uranus, and Neptune, satellites of Mars during the oppositions of 1877 and 1879, &c. Vol xiv. will contain the measures made with the meridian-photometer.

An important and much-wanted bibliographical work has been undertaken by Mr. Chandler, viz., the collecting of references to observations of stars of known or suspected variability, those of each star being brought together; on the completion of this work it is intended to measure the comparison-stars photometrically, and to effect a reduction on a uniform system of all the observations of the variable-stars of long period.

The staff of computers employed upon the ordinary reductions of observations with all three instruments includes several ladies. We suspect that those who are competent and have had opportunity of judging of the work of the lady-computer (who is to be found elsewhere than at Harvard Observatory) will be of opinion that she is well able to hold her own against even the practised computer of the other sex. If proper opportunities and encouragement were afforded, we might hear of Madame Lepautes in our own day.

BIOLOGICAL NOTES

Delicate Test for Oxygen.—T. W. Engelmann proposes, in the *Botanische Zeitung*, a new test, of an extremely delicate nature, for determining the presence of very minute quantities of oxygen, namely, its power of exciting the motility of bacteria. If any of the smaller species, especially *Bacterium termo*, are brought to rest, and then introduced into a fluid in which there is the minutest trace of free oxygen, they will immediately begin to move about freely; and if the oxygen is gradually introduced, their motion will be set up only in those parts of the drop which the oxygen reaches. In this way Engelmann was able to determine the evolution of oxygen by *Euglena* and by chlorophyll-granules.

Prothallium and Embryo of Azolla.—The development of the prothallium and embryo of Azolla, hitherto but imperfectly known, have been followed out by Prof. Berggren (*Lunds Univ. Arsskrift*) in the case of *A. caroliniana*, and found closely to follow the phenomena in Salvinia. The endospore splits, on germination, along its three edges; and the prothallium, on escaping, has the form of a slightly convex disk, consisting in the middle of several layers of cells, at the margin of only one, and separated below by a thin hyaline membrane from the large protoplasmic spore-cavity. Shortly afterwards an archegonium is formed, consisting of four cells inclosing the oospore, and of four neck-cells. When quite mature, the part of the prothallium which projects outside the spore is nearly hemispherical, and three obscure wings are produced by three longitudinal furrows. After fertilisation the oospore is divided by the first oblique division-wall into a smaller upper cell facing the neck of the archegonium, and a somewhat larger lower cell filled with coarse-grained protoplasm. By successive walls vertical to one another and to the first division-wall, and parallel to its longitudinal axis, the embryo is then divided into octants. In each octant a wall next appears parallel to the first division-wall, and the entire embryo then consists of sixteen cells arranged in four parallel rows. After fertilisation the embryo breaks through the prothallium near the archegonium, and the prothallium then surrounds the foot of the embryo like a cup, carrying the withered archegonium on its dorsal side behind the scutellum. To prepare for fertilisation the massulæ of the macrosporangia, with their anchor-shaped glochidia, fix themselves in large numbers to the epispore of the macrospores which are floating on the surface of the water. The central fibrous portion of the floating apparatus is perforated by a narrow canal, through which the antherozoids probably reach the archegonium. By their subsequent growth the prothallium, and later also the embryo, force themselves into this canal and increase its size. By this means the three floating bodies are displaced from their original position, and finally stand at a right angle from the macrospore. The indusium which covers the floating apparatus in the form of a brown cap is at the same time pushed upwards, and finally forced against the embryo. The hood-like fibrous layer which is closely applied to the floating apparatus is turned over, and surrounds the foot of the embryo like a collar. Shortly afterwards the embryo detaches itself from the macrospore, the margins of the scutellum become broader, and then lie on the surface of the water in the form of cups or scales.

Phyllomic Nectar Glands in Poplars.—In a very interesting memoir on this subject, Mr. Wm. Trelease calls attention to the fact that these glands have been very generally overlooked, and that they have been considered of little value by the systematic botanist. He accounts for this by their being occasionally suppressed, and of their limitation to the earlier-formed leaves. Still most of the American botanists refer to them, and Michaux figures them in his monograph of the genus. In May, 1880, Mr. Trelease's attention was drawn to examine the leaves of a small aspen by the action of some bees. The tree was covered with its newly expanded foliage, and the bees were flying from leaf to leaf; they were seen to be collecting nectar which was poured out from a double gland at the base of each leaf. These glands were placed on the upper surface of the petiole at its union with the blade. On section and microscopical examination they showed the usual structure. They were found not to occur on all leaves, but as a rule only on the first half dozen or less which appear on each branch in the early spring; and later on in the season, when these have fallen off, one may sometimes examine all the leaves without detecting a single glanduliferous one, and this on a species which produced

them in abundance earlier in the year. From an examination of the American species it would seem that the greater number possess two or more distinct or confluent glands situated where the blade and petiole join, and in these few species where none were discovered, it is quite possible that a closer examination in the spring time may show that they exist. Thus on *P. tremula*, the weeping variety, a careful examination in early May failed to show a single gland; but a week or two later, after several days' rain, the young branches grew very rapidly for a short time, unfolding many new leaves, and the first three or four of these on each branch bore large and active glands. The nectar is greedily gathered by insects, chiefly Hymenoptera and Diptera. The most numerous were the ants, who, as is usual in such cases, would fight rather than give up a good position near a nectar-secreting gland. The author regards these glands as protective. (The *Botanical Gazette*, Crawfordsville. November, 1881.)

FAUNA AND FLORA OF THE WHITE SEA.—At a meeting of the Natural History Society of St. Petersburg (April 23, 1881) Dr. Chr. Gobi gave a sketch of Prof Cienkowski's report on his expedition to the White Sea, which appears in the *Proceedings* of the Society, in the Russian tongue, and is illustrated with three coloured plates. The bathymetrical distribution of the algæ seems to show a connection between the marine flora of the Solowezk Islands and that of the Scandinavian and Arctic coasts. In the White Sea there is a distinct though fully developed littoral zone, chiefly marked by the presence of Fucoids, with a few Chlorophyceæ and Florideæ. As new to the White Sea flora may be mentioned *Bulbocaulon piliferum*, Pringsh., and *Gloeothamnin palmelloides*, Cnk. The sea was by no means rich in microscopical organisms, but still a few new and interesting forms were found, and are described and figured, such as *Wagneria mereschkowskii*, a new genus and species of Protista, somewhat between Haeckeliana and Clathrulina; several new Flagellata, *Multicilia marina*, new genus and species having a protoplasmic body of protean form without nucleus or contractile vesicle, but having several cilia; *Exuviaella marina* also new, with an ovum-like body, flattened horizontally at the top, with two cilia and one or two round marks (*Schildchen*); *Daphnidium boreale* n.g. and sp., with a spherical body, prolonged into a curved beak, giving origin to one long cilium. In the dead cells of Pylaicella and other Phæospores there was found a colourless form of a Labyrinthula which had previously been found thriving in the cells of a Lemna; Finally, a new Moner, *Gobiella borealis*, which shows a great resemblance to Vampyrella, but the green contents seem never to extend into the pseudopodia (*Botanische Zeitung*, January 13, 1882.)

THE GROWTH OF PALMS.—In a paper (Russian) recently read before the Botanical Section of the St. Petersburg Natural History Society, Mr. K. Fridcrich describes in detail the anatomical structures to be met with in the ærial roots of *Acanthorhiza aculeata*, these roots presenting a remarkable example of roots being metamorphosed into spine. Supplementing this, E. Regel made the following remarks:—Palm trees, grown from seed, thicken their stems for a succession of years, like bulbs, only at the base. Many palms continue this primary growth (*i.e.* the growth they first started with) for fifty to sixty years before they form their trunk. During this time new roots are always being developed at the base of the stem, in whorls, and these always above the old roots. This even takes place in old specimens, especially in those planted in the open ground which have already formed a trunk. In such cases the cortex layer, where the roots break through, is sprung off. In conservatories, under the influence of the damp air, this root-formation, on which indeed the further normal growth of the palm depends, takes place without any special assistance. When the palm is grown in a sitting-room, one must surround the base of the trunk with moss, which is to be kept damp, in order to favour the development of the roots. When the base of the palm-trunk has almost reached its normal thickness, then begins the upward development of the trunk which takes place more slowly in those species whose leaves grow close together than in those whose leaves are further apart. In specimens of many species of Cocos and Syagrus, whose leaves are particularly far apart, the stems grow so quickly when planted in the open ground that they increase by five to six feet in height per annum. The stem of those palms which develop a terminal inflorescence have ended their apical growth by doing so, and wither gradually. In addition to this (withering) in the case *e.g.* of *Arenga saccharifera*, new inflorescences are developed from the original axils (*Blattachseln*) from above downwards, so that one sees at last the already leafless trunk still developing inflorescences in the direction towards the base of the trunk. Almost all palms with this latter kind of growth develop off-hoots in their youth at the base of their trunks which shoot up again into trunks after the death of the primary trunk, if they are not taken off before. As to the structure of the palm-trunks out of unconnected wood-bundles, the assertion has been made that the palm-stem does not grow thicker in the course of time, and that this is the explanation of the columnar almost evenly thick trunk. But careful measurements that were made for years have led Regel to the conclusion that a thickening of the trunk actually takes place, which probably amounts to an increase of about a third over the original circumference of the trunk.

ACTION OF GASES AND LIQUIDS ON THE VITALITY OF SEEDS

MY experiments extend over a period of nearly three years. They were made principally with the seeds of *Medicago sativa*, these seeds resisting in a remarkable manner the action of chemical agents. The observations were very numerous and frequent; but in the present abstract those results alone are given in which the action of the gases and liquids lasted longest.

I. *Action of Gases.*—The chief difficulty in these experiments is an easy method of keeping many samples of seeds in the several gases the action of which is to be tested. I devised the following simple plan:—A thick glass tubing was heated in the middle and blown into a bulb of sufficient size to contain a certain quantity of seeds and a relatively large volume of gas; after introducing the seeds into the bulb, the two extremities of the tube were heated, and drawn out, so as to form, on each side of the bulb, a nearly capillary neck; one end was left free, while the other was connected, by means of an india-rubber tube, with the generator of the gas that was to fill the bulb. The air was completely displaced in the latter by allowing the gas to pass for some time through the apparatus; after which, without previously interrupting the passage of the gas, the bulb was sealed by fusing at the blowpipe the two capillary necks.

I prepared a large number of bulbs with seeds and with different gases; the greater number of bulbs contained air-dry seeds, while some contained seeds that had been moistened and swollen with water. On opening the bulbs the seeds were sown, and their vitality measured by the percentage of those that germinated on moist quartz sand.

Experiments with air-dry seeds of *Medicago sativa* in dry gases:—

Gas.	Number of days in which the seeds remained in the gas.	Percentage of seeds that retained the germinating power.
Air (not in bulbs) ...	More than two years	... 83
Air (not in bulbs—another sample) ...	More than three years	... 50
Nitrogen	789 ...	... 93
Oxygen	758 ...	... 59
Hydrogen	1005 ...	... 63
Carbon monoxide ...	803 ...	... 93
Carbon dioxide ...	1035 ...	... 24
,, ,, ...	408 ...	... 73
Marsh-gas	550 ...	... 58
Nitrogen protoxide ...	214 ...	... 70
,, dioxide ...	776 ...	... 48
Ammonia	832 ...	... 0·5
,, ...	398 ...	... 1·2
Sulphur dioxide ...	838 ...	... 4·5
,, ,, ...	405 ...	... 10·6
Sulphuretted hydrogen.	976 ...	... 58
Arseniuretted ,,	802 ...	... 87

Chlorine and hydrochloric acid gas rapidly disorganise the seeds, and destroy their vitality. It is remarkable how air-dry seeds can resist for so long a time the action of nitric oxide, of sulphuretted hydrogen, and of sulphur dioxide, and how some can even survive the action of dry ammonia-gas. The percentages that represent the vitality of the seeds that have been under the action of the different gases cannot be compared, for the experiments were not all begun at the same time, nor extended over the same period, nor was the same sample of seeds used in all the experiments.

Whenever seeds moistened with water are kept in the above-named gases, their germinating power is very rapidly destroyed.

It is also a well-ascertained fact that moist heat acts much more powerfully on seeds than dry heat. We may safely conclude therefore that when the physical and chemical conditions of the medium in which a seed is placed are unfavourable to its germination, water is the most powerful agent in rapidly destroying its vitality. My experiments on the action of liquids on seeds confirm this conclusion.

Moist seeds kept in oxygen and in nitrogen protoxide do not germinate. In some few cases I observed the commencement of sprouting in seeds kept in oxygen. My observations confirm those of Cossa, and are contrary to those of Borscow and Rischawi, who asserted that nitrogen protoxide can cause moistened seeds to germinate.

II. *Action of Liquids.*—The air-dry seeds were kept in the different liquids in well-stoppered bottles. In some liquids several kinds of seeds were put. The following are some of the results of experiments with the seeds of Lucerne or *Medicago sativa* :—

Liquids used.	Number of days in which the seeds remained in the liquid.	Percentage of seeds that retained the germinating power.
Methyl alcohol...	841	19
Ethyl ,, (absolute)	834	78
Amyl ,,	841	19
Ethyl ether	484	29
,, ,,	908	1·3
Chloroform	484	29·6
,,	841	6
,,	924	0
Carbon tetrachloride	350	57·4
,, disulphide	405	63·2
,, ,,	802	58·4
Ethyl iodide	350	65·4
,, ,,	792	52·5
Glycerine	157	24·2
,,	484	5·2
Benzol ...	397	20
,,	841	8·6
Nitrobenzol	397	17·4
,,	841	6·0
Aniline ...	397	20·1
,,	841	4·2
,, and alcohol (93°)	709	37

In the experiments with methyl alcohol and with glycerine the presence of small quantities of water must have contributed not a little in augmenting the action of the liquid on the vitality of the seeds.

Experiments were made to see the action of ethyl-alcohol when at different degrees of dilution. It was observed that, when the solution contained less than 50 per cent. of alcohol, the seeds easily got swollen, and were rapidly killed. The following are the results of experiments where Lucerne seeds, from the same sample, were kept for 834 days in different mixtures of alcohol and water :—

Degree of the alcoholic solution, Gay-Lussac's scale, per cent. in volume.	Percentage of seeds that retained the germinating power.
60	0
70	0
80	23
90	62
100	63
100 *bis*	78

Absolute or nearly absolute, alcohol rapidly destroys the germinating power of some kinds of seeds, such as wheat, flax, &c.

In some cases seeds resist the action even of boiling liquids, when the temperature of the boiling point is not too high. Thus, of Lucerne seeds that had been for 160 hours in boiling ether (boiling point 36°) 31 per cent. were still capable of germinating. Seeds of the same plant were kept for 81 hours in boiling carbon disulphide (boiling point 43°) : 75 per cent. of the seeds sprouted when sown in moist sand. After five hours boiling in absolute alcohol (boiling point 78°) only 9½ per cent. of the Lucerne seeds did germinate.

In all the experiments where seeds, previously swollen in water, were brought in contact with other liquids, such as absolute alcohol, ether, carbon disulphide, the germinative power was quickly destroyed.

The last series of experiments was made with solutions of solids and gases in liquids different from water. Great care had to be taken in washing the seeds, the germinative power of which had to be tested on the moist sand well with alcohol, and then with water ; the presence, even of traces, of the solution in which the seeds had been immersed was sufficient, in some cases, to entirely prevent germination. The following are experiments made with Lucerne seeds :—

Solutions used.	Number of days in which the seeds remained in the solution.	Percentage of seeds that retained the germinating power.
Alcoholic solution of iodine ...	382	1·5
,, ,, potassium bromide	757	68·4
,, ,, zinc chloride ...	757	34·6
,, ,, ,, ,, ...	376	83·6
,, ,, mercuric chloride.	756	68·4
Glycerine ,, copper sulphate ...	757	23·1
,, ,, ,, ,, ...	375	67·1
,, ,, arsenic trioxide ...	758	1·3
,, ,, ,, ,, ...	322	70·2
Alcoholic ,, potassium sulphide	223	8·2
,, ,, ammonium ,,	223	0
Glycerine ,, potassium cyanide	757	80
,, ,, ,, ,,	376	95·3
Alcoholic ,, camphor ...	757	70·4
,, ,, phenol ...	757	65
Ether ,, ,, ...	598	69·4

All these solutions easily destroyed the germinating power of wheat.

The following results show the action of saturated alcoholic solutions of gases on Lucerne seeds :—

Solution (alcohol at 97° Gay-Lussac).	Number of days in which the seeds remained in the solution.	Percentage of seeds that retained the germinating power.
Alcoholic solution of sulphuretted hydrogen ...	587	27
,, ,, sulphur dioxide	587	3
,, ,, nitric oxide ...	587	20

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UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—Dr. Acland, Dr. Burdon Sanderson, and Mr. W. W. Fisher, having been appointed examiners for the Radcliffe Travelling Fellowship, give notice that an examination will be held for the purpose of electing a Travelling Fellow on Tuesday, February 14. Candidates are to send their names to Mr. Fisher before February 8.

There will be an examination at Christ Church on February 22 for at least one Junior Studentship in Natural Science ; papers will be set in Chemistry, Biology, and Physics ; but no candidate will be allowed to offer himself for examination in more than two of these subjects.

Candidates for the Natural Science Studentships who make Physics their principal subject are recommended to offer themselves for examination in Mathematics, at least in Algebra, Plane Trigonometry, and Pure Geometry, as great weight will be attached in their case to a knowledge of these subjects.

Candidates for the Natural Science Studentships will also have to show that they possess such a knowledge of Classics as will enable them to pass Responsions.

On February 7 Convocation will be asked to pass a decree authorising the Curators of the University Chest to pay to the Delegates of the Museum a sum not exceeding 250*l.*, for the purpose of providing the Linacre Professor of Physiology with additional microscopes, diagrams, and drawings for the use of students in the Physiological Laboratory, as well as with additional cupboards for containing diagrams and drawings.

CAMBRIDGE.—The following elementary lectures on chemistry are being given :—Prof. Liveing's and Mr. Main's (St. John's College) General Courses ; Mr. Pattison Muir (Caius), Non-Metallic Elements ; Mr. Lewis (Downing), Catechetical Lectures ; Mr. Walker (Sidney), Organic Chemistry ; Mr. Garnett is lecturing on Heat at St. John's ; Mr. Glazebrook (Trinity),

also on Heat; and Mr. Shaw (Emmanuel), on Conservation of Energy.

The followin g are advanced lectures:—Organic Chemistry, Prof. Dewar; Physical Optics, Mr. Trotter (Trinity); Electricity and Magnetism, Mr. Garnett (St. John's).

Practical Chemistry at the University, St. John's, Caius, and Sidney Laboratories. Practical Physics at the Cavendish Laboratory; also advanced demonstrations by Messrs. Shaw and Glazebrook.

In geology Prof. Hughes is lecturing on Stratigraphical Geology; Mr. Tawney, on Fossil Echinoderms and Crustaceans, and on Petrology. Dr. Roberts (Clare College) is also taking a class in Petrology; and Prof. Hughes makes periodical field excursions.

Dr. Vines (Christ's) lectures on the Anatomy of Plants, with practical work; Mr. Hicks (Sidney), on Elementary Botany, chiefly Morphology; Mr. Saunders (Downing), on Elementary Botany; and Mr. Hillhouse, on the Anatomy and Physiology of Plants, at the Museums.

Prof. Newton takes Vertebrata this term (lectures on Geographical Distribution once a week). Mr. Balfour gives elementary and advanced lectures on Morphology, with practical work, as usual. Dr. Foster's elementary course of Physiology is continued; and the advanced lectures are Dr. Gaskell's, on Respiration; Mr. Langley's, on the Digestive System; and Mr. Hill's, on the Central Nervous System.

Prof, Humphry lectures on the nervous system and the Organs of Special Sense, and takes a class for Tripos and 2nd M.B. work in Anatomy and Physiology. Dr. Creighton has a class for Osteology, and Practical Human Anatomy commenced on January 20.

Prof. Stuart is lecturing on the Theory of Strictures. The Demonstrator of Mechanism will form classes in elementary and advanced mathematics applicable to engineering.

The last Senior Wrangler under the old regulations is Mr. R. A. Herman, of Trinity College, educated at King Edward's School, Bath; his private tutor was Mr. Routh. The second wrangler is Mr. J. S. Yeo, of St. John's College, educated at Blundell's School, Tiverton; his private tutor was Mr. R. R. Webb, of St. John's. The third wrangler is Mr. S. S. Loney, of Sidney College, educated at Maidstone Grammar School and Tonbridge School: private tutor, Mr. Routh. St. John's has four wranglers of the first eight; Trinity has only one wrangler besides the Senior.

SOCIETIES AND ACADEMIES

London

Royal Society, December 8, 1881.—"On the Development of the Skull in *Lepidosteus osseous*," by W. K. Parker, F.R.S.

The materials for the present paper were kindly sent to me by Prof. A. Agassiz; they were for the use of Mr. Balfour and myself, and consisted of fifty-four small bottles of eggs and embryos in various stages. These very valuable materials were obtained from Black Lake by Mr. S. W. Garman and Prof. Agassiz, and many of the embryos were described and figured by the latter in the *Proceedings* of the American Academy of Arts and Sciences, October 8, 1878.

We have had additional materials from Prof. Burt G. Wilder; Mr. Balfour has obtained from Prof. Agassiz several adult fishes in spirit; and I am indebted to Prof. Flower for an adult in the dry state.

Mr. Balfour's part of the work has been done with the assistance of my son, Mr. W. N. Parker, and their joint labour will include the anatomy of various organs of the adult fish.

My observations on the skull and visceral arches have been made on embryos and young, varying from one-third of an inch to 4½ inches in length; I have (artificially) divided these into six stages. Cartilage was being formed in the smallest examined by me, but in my second stage, embryos five-twelfths of an inch long, this tissue was quite consistent, and I succeeded in dissecting out all the parts. The large notochord at this stage bends downwards under the swelling hind-brain, and turning up a little at its free end, and passing into the lower part of the fissure between the mid- and hind-brain, it reaches beyond the middle of the cranium, and just touches the infundibulum and *distinct* pituitary body. Between the trabeculæ, in front, there is a small wedge of younger cartilage, the rudiment of the "intertrabecula."

As in the Batrachia, the fore part of the palato-quadrate cartilage is continuous with the trabeculæ in front; but the pedicle is free behind. The free articulo-Meckelian rod is quite in front of the eye-balls, and is nearly as long as the hind suspensorium, or proper quadrate region; this forward position of the hinge of the mandible is not temporary, as in the frog, but permanent. The uppermost element of the hyoid arch is an anvil-shaped cartilage from the first, and ossifies afterwards, as the hyo-mandibular and symplectic bones. As pointed out to me by Mr. Balfour, its dorsal end is continuous, *as cartilage*, with the auditory capsule above. The basi-hyal is not yet ossified, but distinct inter-, cerato-, and hypo-hyal segments are already marked out. Four larger and one small rod of cartilage are seen on each side, articulating with a median band; these are the branchial arches, which chondrify before they undergo segmentation. In this stage there are no osseous laminæ as yet formed.

Here, in this stage, in connection with a large pre-nasal suctorial disk, we have three important generalised characters, namely, the continuity of the distal end of the mandibular pier and of the proximal end of the hyoid pier with the skull, and the forward position of the hinge of the jaw coupled with the horizontal direction of the suspensorium. The hyoid arch has its segments formed much earlier than in the Teleostei, and the "pharyngo-branchials" are not independent cartilages, as in the *Skate*.

The third stage—embryos two-thirds of an inch long—show a considerable advance in the development of the skull; the cartilage, generally, is more solid and more extensive, and new tracts have appeared. The apex of the notochord is now in the middle of the basis cranii, for the pro-chordal tracts have grown faster than the para-chordals. The trabeculæ swell out where they are confluent, and then are narrower in front again. At their fore end each band passes insensibly into the corresponding palato-quadrate bar outside, whilst inside they are separated by a large pyriform wedge of cartilage, the intertrabecula. The thick, rounded, free fore end of this median cartilage is the rudiment of the great "nasal rostrum," and the rounded fore ends of the trabeculæ are the rudiments of their "cornua."

There is only a floor in the occipital region, but the wall-plate of the chondrocranium has begun as a styloid cartilage running forward from the fore end of each auditory capsule into the superorbital region. The palato-pterygoid bar—continuous in front with the trabeculæ—is now longer than the proximal part of the suspensorium, the spatulate quadrate region whose dorsal end is the free pedicle. The wide proximal part of each trabecula is now already forming an oblong facet, the basipterygoid, for articulation with the facet of the pedicle.

In this stage the skull is a curious compromise between that of a salmon at the same stage and that of a tadpole just beginning its transformation. The hind-skull is quite like that of a young salmon, the fore-skull, with its non-segmented palatoquadrate, and its forwardly placed quadrate condyles and horizontal suspensorium, is very much like what is seen in the suctorial skull of the Anurous larva. A splint bone, the parasphenoid, as in the tadpole, has now made its appearance.

The largest embryos reared by Messrs. Agassiz and Gorman, which are about one inch in length, form my *fourth* stage; these are rapidly acquiring the character of the adult.

This is the stage in which the chondrocranium of this Holostean type corresponds most closely with that of the Chondrostean sturgeon, whose adult skull is similar to that of garpike just as the latter begins to show its own special characters. This important difference is already evident, namely, that whilst in *Acipenser* the olfactory capsules remain in the *antorbital* position, those of *Lepidosteus* are already carried forwards by the growing intertrabecula, and are even now in front of the relatively huge cornua trabeculæ. Thus these regions are now well grown in front of the ethmoidal territory, which, instead of being, as in the last stage, in the front margin of the skull, is now fairly in its middle, and this change has taken place whilst the embryo has only become one-half larger—from two-thirds of an inch to an inch in length. It is the hypertrophy of cartilage in the three trabecular tracts that makes the rostrum of the sturgeon so massive, even whilst only a few inches in length, and this state of things exists temporarily in the garpike.

Above, the sphenotic, epiotic, and opisthotic projections of the auditory capsule are more evident, but are not ossified. Some slight bony deposit has appeared in the pro-otic regions. The "cephalostyle" is the first *endo*-cranial bone, and the para-

sphenoid the first *ecto*-cranial centre; but the exoccipitals are just appearing also.

The superficial bones can now be seen as fine films in the transverse sections, and the parosteal palatine and pterygoid are large leaves of bone applied to the pterygopalatine bar; the mesopterygoid is only half as large as them, but is relatively much larger than in the adult.

While doubling its length, the young *Lepidosteus* gains a cranium much more like that of the adult; this is my *fifth* stage. The general form is now intensely modified by the foregrowth of the rostrum, which is two-thirds the length of the entire skull. The cornua trabeculæ now reach only two-fifths of the distance to the end of the beak, and the pterygopalatine arcade reaches but little further forwards. The bony matter of the "cephalostyle" is now aggregated towards the hinder half of the notochord; it is now the basi-occipital bone. The exoccipitals and pro-otics are growing larger, and there are both sphenotics and alisphenoids. Also, below, the quadrate, metapterygoid, and articular centres have appeared; and behind the jaw there are the hyomandibular, symplectic, epihyal, ceratohyal, and hypo-hyal centres; and the epi-, cerato-, and hypobranchials have acquired a bony sheath.

In a young *Lepidosteus* $4\frac{1}{2}$ inches long (nearly), the approach to the adult state of the skull has been very great; the superficial bones can all be determined. The most remarkable of these are the small distal nasals and premaxillaries: the long *maxillary chain*, ending in an os mystaceum and jugal; the extremely long and slender "ethmo-nasals" and vomers; the small preopercular; and the huge angulated inter-opercular, which carries the large opercular and the sub-opercular. The five mandibular splints are all present (as in most Sauropsida), the branchiostegals are only three in number, as in the Carp tribe.

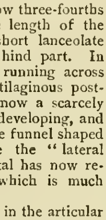
The intertrabecula, which was at first merely a small tract of cells binding the trabeculæ together in front, is now three-fourths the length of the entire skull; to it is due the length of the beak. The cornua trabeculæ are now merely short lanceolate leafy growths on the sides of the rostrum at its hind part. In the last stage there was a fine bridge of cells running across behind the pituitary body; it is now a small cartilaginous post-clinoid bar. The opisthotic and epiotic form now a scarcely divided tract of bone, all the other centres are developing, and a pair of additional bones have appeared in the funnel shaped fore-end of the chondrocranium; these are the "lateral ethmoids." The bony matter of the basi-occipital has now retired to the hinder third of the notochord, which is much shrunken.

There are now two centres (as in *Amia calva*) in the articular region of the mandible; the quadrate and metapterygoid centres are much larger; the hyo-mandibular and symplectic are together only half the size of the mandibular suspensorium; the basi-hyal is very large, is composed of two parallel pieces, and is very *Myxinoid*.

No clear understanding of the morphology of this type of skull can be had unless it be seen in the light derived from that of the Elasmobranchs, the Sturgeon, and the Anurous larva on one hand, and that of *Amia calva* and the Teleostei on the other.

Royal Society, January 12.—"On a New Electrical Storage Battery (Supplementary Note)." By Henry Sutton. Communicated by the President.

The new cell consists of a flat copper case, same shape as a Grove's cell; it has a lid of paraffined wood, from which hangs a plate of lead amalgamated with mercury, the lower part of lead plate being held in a groove in a slip of paraffined wood resting on bottom of copper case; through the lid a hole is bored for introduction of solution, which consists of a solution of cupric sulphate, to which is added one-twelfth of hydric sulphate; the presence of this free sulphuric acid improves the cell at once.



The sectional sketch shows the arrangement.

A B. The outer flat copper case.

C. Plate of amalgamated lead held in grooves in cap D and slip E.

F shows the hole in cap through which the solution is introduced, and by the introduction of a glass tube through this hole the state of the charge is seen by observing the colour; the interior surface of the case forms the negative electrode, and the amalgamated lead the positive.

Linnean Society, January 19.—Sir John Lubbock, Bart., F.R.S., President in the chair. Mr. R. Kippist's death was officially notified, and a valuable donation of books from the late treasurer (Mr. Currey) announced. There were exhibited, for Mr. Thomas Bruges Flower, three rare British plants, viz.: *Potentilla rupestris*, L., from Montgomeryshire, *Polygonum maritimum*, L., and *Senecio squalidus*, L., from North Devon; and, for Mr. W. Bancroft Espeut, an albino specimen of Bat., (*Molossus obscurus*, Geoff.) from Jamaica; albinism in the cheiroptera being said to be extremely rare. Dr. T. Spencer Cobbold called attention to living examples of *Leptodera* under the microscope. Mr. G. Maw read a communication on the Life History of a Crocus and classification and distribution of the genus. He says the corm tunic is the only permanent record of perennial existence, and even this in the living state lasts but a year. Minute papillæ stud the surface of the corm, these increase as bud-growth and ultimately secure the life cycle; the new corm is implanted on and finally absorbs the parent. The tunics are homologous with leaves, and their fibrous net-like structure has so many ornamental patterns that by a fragment a species can be determined. Certain *Croci* are constant in colour, others are exceedingly variable, and still others change in tint as found from east to west: *C. cancellatus* being purple in Asia Minor, lilac in Greece, and white in the Ionian Islands. The stigmata are so variable that Mr. Maw thinks that Mr. Baker's threefold classification, based thereon, fails. Grouping of the genus is necessarily to be founded on a combination of characters, for the overlapping and interlacing of single ones militate against the natural sequence of species. A modification of Dean Herbert's classification is, by the author, preferred to those of Haworth and Baker. The crocuses are geographically confined to the Old World and Northern Hemisphere, their chief area of distribution being around the Mediterranean and Black Sea. Mr. Maw divides their region of occupation into nine sub-districts. *C. biflorus* has the widest range of longitude, and extends from Italy into Georgia, and *C. sativus* follows, ranging from Italy to Kurdistan. Certain Mediterranean islands, on the other hand, present curious examples of quite a local distribution. The author expresses doubts of the existence of wild hybrids; and he points out the great tendency to morphosis of nearly every part of the plant.—Mr. W. Percy Sladen read a paper "On the Asteroidea of the 'Challenger' Expedition." The family Pterasteridæ, he remarks, has been heretofore but feebly represented in living forms; 8 species only being on record as belonging to the genera *Pteraster* and *Retaster*, and a 9th solitary representative to *Hymenaster*. From the *Challenger* collection 34 species of Pterasteridæ have been obtained, 2 only known previously. Of the 32 new species, 3 belong to *Pteraster*, 4 to *Retaster*, and 20 to *Hymenaster*—a genus now found to be world-wide in deep waters. The remaining 5 species are the representatives of 3 new genera, viz.: *Marsipaster* 2, *Benthaster* 2, and *Calyptraster* 1 species.—The Rev. G. Henslow read a note "On the Occurrence of a Staminiferous Corolla in the Foxglove and in the Potato"; staminody in these plants seldom having been recorded and figured.

Chemical Society, January 19.—Prof. Roscoe, president, in the chair.—The following papers were read:—On the chemistry of Bast fibres by C. F. Cross and E. J. Bevan (we give a report of this elsewhere).—Dr. Carnelley then read a paper on the action of heat on mercuric chloride. About twelve months ago the author exhibited to the Society some experiments on the action of heat on ice and mercuric chloride under low pressures, and subsequently read a paper on the subject before the Royal Society. Two propositions were advanced—(1) that when the superincumbent pressure is maintained below a certain point called "the critical pressure," it is impossible to *melt* ice, mercuric chloride, and probably other substances, no matter how great the heat applied; (2) that under these circumstances ice and mercuric chloride attain temperatures considerably above their natural melting-points without melting. Subsequent observers have confirmed the first proposition, but have been unable to verify the second. The author has therefore repeated his previous experiments with mercuric chloride, and in addition has made determinations of the temperature of mercuric chloride, heated in a vacuum, by dropping the heated solid into a calorimeter containing turpentine, benzine, and petroleum. Some unexpected results were obtained. When the salt is pressed as a compact powder round the bulb of the thermometer, and heated in a vacuum, the thermometer rises 21° to 50° above

the melting-point of the mercuric chloride, though still surrounded by the solid salt. When the salt is in the form of a solidified cylinder, the temperature rises 15° above the melting-point. When a turpentine calorimeter is used, the temperature of the mercuric chloride came out 100° above the ordinary melting-point; but with petroleum or benzine, temperatures above the ordinary melting-point could not be obtained. The author therefore withdraws his previous statement, and concludes that although mercuric chloride does not fuse when heated under diminished pressure, yet its temperature never rises appreciably above its ordinary melting-point. The high temperatures indicated by the thermometer being due to the diffusion of the superheated vapours of the mercuric chloride through the pores of the solid salt. The author also concludes that turpentine cannot be used in a calorimeter for the determination of the specific heat of bodies soluble in water, since some substances such as mercuric chloride, zinc chloride, &c., when heated, cause an evolution of heat, due probably to the polymerisation of the turpentine. Hence many of Regnault's specific heat determinations, in which turpentine was employed, are probably too high; they are, it may be remarked, in almost all cases higher than Kopp's numbers, that observer having used coal-tar naphtha. The specific heat of mercuric chloride is 0·06425, and of zinc chloride 0·14301, neither value being altered by a rise of temperature.—Contributions to the history of cerium compounds, including the analysis of Rhabdophane, a new British mineral containing Cerium, Lanthanum, Didymium, Yttrium, by W. N. Hartley.—On the reaction of chromic anhydride with sulphuric acid, by C. F. Cross and A. Higgin.—On dibenzoybanilin and its isomerides, by A. Higgin.

Entomological Society, January 18.—Annual Meeting.—An address was delivered by the president, H. T. Stainton, F.R.S., and the following gentlemen were elected to serve on the Council for 1882:—President, H. T. Stainton, F.R.S. Treasurer, E. Saunders, F.L.S. Librarian, F. Grut, F.L.S. Secretaries: E. A. Fitch, F.L.S., and W. F. Kirby. Other Members of Council: W. Cole, F. Du Cane Godman, F.L.S., F. P. Pascoe, F.L.S., O. Salvin, F.R.S., W. A. Forbes, B.A., F.L.S., F.G.S., Rev. H. S. Gorham, Lord Walsingham, M.A., F.Z.S., and C. O. Waterhouse.

PARIS

Academy of Sciences, January 23.—M. Jamin in the chair.—The following papers were read:—On the explosive wave, by M. Berthelot. It is not a sound-wave travelling with a velocity depending on the physical constitution of the medium, but a change of chemical constitution propagated. M. Berthelot recapitulates its properties. As to dependence of the velocity on the diameter, this becomes less and less as the increase of the diameter allows more freedom of motion to the molecules and diminishes friction. The total energy of the gas, at the moment of explosion, depends on its initial temperature and the heat liberated during combination. These two data determine the absolute temperature of the system, which, moreover, is proportional to the kinetic energy ($\frac{1}{2}mv^2$) of translation of the molecules. It follows that the velocity of translation is proportional to the square root of the ratio between the absolute temperature and the density of the gas referred to air. The result of experiments agrees closely with this.—*Résumé* of meteorological observations made during 1881 at four points of Haut-Rhin and the Vosges, by M. Hirn. The stations are—Thann (alt. 350 m.), Munster (alt. 388 m.), Col de la Schlucht (alt. 1154 m.), and Colmar (alt. 195 m.). *Inter alia*, the maximum difference between a black-bulb thermometer and an ordinary one at the same height in shade at Colmar was 27·6 (in January). The most violent winds at Colmar never exceeded 18 to 20 metres per second. The rainfall at Schlucht was 1310·8 mm., at Munster 664 mm., at Colmar 521 mm.—Spectroscopic observations with monochromatic light, by M. Zenger. Seeking combinations which should give strong dispersion with perfect transparency and total reflection of red or violet, he finds that benzine and benzylene, combined with quartz, eliminate the extreme red of an angle of about 75°, while pure anethol, at the same angle, eliminates the extreme violet. A parallelepiped thus formed is the best means of observing the solar protuberances or spots, or the reversed colours of the chromosphere. He commends it to the Transit of Venus Commission. Irradiation is abolished or greatly reduced. Larger magnifying power may be used. The confusion arising from interference-bands at the edge of Venus' disc is obviated. And better photographs may be had.—Remarks on a note of MM. Mignon and Rouart, on processes of coppering, by M. Weil. He denies that he uses organic acid merely as an accessory.—On the spherical representation of surfaces, by M. Darboux.—On some transcendent equations, by M. Laguerre.—On Fuchsian functions, by M. Poincaré.—On a means of extending the theory of imaginaries, without making use of imaginaries, by M. Saltel.—New manner of employing the principle of least action, in questions of dynamics, by M. Brassinne.—Determination, by means of the microphone, of the nodes and ventral segments in vibrating columns of air, by M. Serro-Carpi. A small graphite microphone is applied to an elastic membrane on a ring, and this is brought into the sounding-pipe. The presence of a node is indicated by a roll (*roulement*) in the telephone, like that which the instrument gives with induced currents. In the ventral segments the sounds are more apart and rare. One does not hear the musical sound of the piece.—On spermatogenesis in Annelids and Vertebrates, by M. Sabatier. In Annelids he has observed two generations of spermatoblasts formed on the inner surface of the spermatic pouches. The second, springing from the first, are transformed into spermatozoids (the nuclei forming the heads). M. Sabatier considers that spermatogenesis in Vertebrates may be similarly explained.—On the *rôle* of the amnios in the production of anomalies, by M. Daresti. In an anomalous fœtus of sheep he finds confirmation of his view that deviations, and especially congenital club-foot in man, are the consequence of compression of the body of the embryo by the amnios arrested in its development.—On the vegetation of aquatic plants in air, by M. Mer. He concludes, that if certain aquatic plants cannot form branches in free air, it is simply because their tissues are unable to resist active transpiration, and not, as in the case of aerial plants immersed, because they are incapable of development and nutrition in air. They can live in air, provided this is moist, and can produce starch in it sometimes more easily than in water. But there are very few in which the same leaf will act in both media.—On the concentric bands of felspars, by M. Lévy.—On the barometric height of January 17, 1882, by M. Renou. This on the parc de Saint Maur (alt. 49·30 m.) at 10 a.m. was 782·13 mm; reduced to sea-level, 786·92 mm. During nearly a century, there has only been one height slightly exceeding this, at Paris Observatory. On February 6, 1821, at 9 a.m., the height was 780·90 mm., at sea-level, 787·52 mm. It would appear that at Paris during two centuries, with exception of the figures in 1821 and 1882, the barometer has never exceeded 778·5 mm. M. Renan gave an explanation of the recent high pressure. M. Faye attributed to the pressure a remarkable depression of the sea-level observed at Antibes (in the south of France), about which M. Naudin had written him. It lasted a fortnight.

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THURSDAY, FEBRUARY 9, 1882

PROFESSOR HUXLEY'S ESSAYS

Science and Culture, and other Essays. By Thomas Henry Huxley, LL.D., F.R.S. (London: Macmillan and Co., 1881.)

THIS collection of Prof. Huxley's more recent lectures and essays appears as a companion volume to the previous well-known collections of the same kind. The first thing, therefore, that naturally occurs to us is to compare this series with its predecessors, for when an author has been so long and so prominently before the public as Prof. Huxley, and when the authorship has been of a kind so varied and original, we cannot but entertain fears, even for the strongest man, that signs of exhaustion may become apparent in the works of his middle life. But if any one should entertain such charitable apprehensions on behalf of Prof. Huxley they may immediately be quieted by the book before us; the eye is as clear for seeing and the arm as strong for hitting as they have always been, and on every page we meet with new instances of that same versatility of learning, force of thought, and brilliancy of style which, while producing so wide an influence on the science and philosophy of our time, have justly placed this distinguished leader of both in a class *sui generis* as an expositor.

The first essay, as the title of the collection signifies, is that on Science and Culture.

"From the time that the first suggestion to introduce physical science into ordinary education was timidly whispered, until now, the advocates of scientific education have met with opposition of two kinds. On the one hand they have been pooh-poohed by the men of business who pride themselves on being the representatives of practicability, while on the other hand they have been excommunicated by the classical scholars, in their capacity of Levites in charge of the ark of culture and monopolists of liberal education."

The first of these two classes of opponents is easily disposed of, notwithstanding that "your typical practical man has an unexpected resemblance to one of Milton's angels; his spiritual wounds, such as are inflicted by logical weapons, may be as deep as a well and as wide as a church door, but beyond shedding a few drops of ichor, celestial or otherwise, he is no whit the worse." But the other class of opponents is more formidable, and as the essay is "an Address delivered at the opening of Sir Josiah Mason's Science College at Birmingham," Prof. Huxley observes—

"It is not impossible that we shall hear the express exclusion of 'literary instruction and education' from a College which, nevertheless, professes to give a high and efficient education, sharply criticised. Certainly the time was that the Levites of culture would have sounded their trumpets against its walls as against an educational Jericho."

The address therefore proceeds to justify the action of the founder in having imposed this exclusion.

"For," says Prof. Huxley, "I hold very strongly by two convictions. The first is, that neither the discipline nor the subject-matter of classical education is of such direct value to the student of physical science as to justify the expenditure of valuable time on either; and the second is, that for the purpose of attaining real culture, an exclusively scientific education is at least as effectual as an exclusively literary education."

The remainder of the essay proceeds to make good these two propositions, and in the course of doing so gives an interesting historical sketch of the circumstances which have hitherto led to an undue depreciation of the study of science as an instrument of mental culture. In the Middle Ages, and so long as theological dicta held exclusive sway, men "were told how the world began and how it would end; they learned that all material existence was but a base and insignificant blot upon the fair face of the spiritual world, and that nature was, to all intents and purposes, the playground of the devil." Although this statement of the case is, as it is no doubt intended to be, hyperbolical rather than historical, there can be no question that it "was far from the thoughts of men trained" in the system of mediæval theology to suppose "that the study of nature—further than was requisite for the satisfaction of everyday wants—should have any bearing on human life." But—

"The distinctive character of our own times lies in the vast and constantly increasing part which is played by natural knowledge. Not only is our daily life shaped by it, not only does the prosperity of millions of men depend upon it, but our whole theory of life has long been influenced, consciously or unconsciously, by the general conceptions of the universe which have been forced upon us by physical science."

Therefore it is obvious that we must now hold a different estimate of the importance of physical science in relation to culture, if with Mr. Matthew Arnold we mean by culture "the knowledge of the best that has been thought and said in the world."

"The period of the Renascence is commonly called that of the 'Revival of Letters,' as if the influence then brought to bear upon the mind of Western Europe had been wholly exhausted in the field of literature. I think it is very commonly forgotten that the revival of science, affected by the same agency, although less conspicuous, was not less momentous. . . . . We falsely pretend to be inheritors of their culture [*i.e.* that of the Greeks], unless we are penetrated, as the best minds among them were, with an unhesitating faith that the free employment of reason, in accordance with scientific method, is the sole method of reaching truth."

The address continues:—

"But I should be very sorry that anything I said should be taken to imply a desire on my part to depreciate the value of classical education, as it might be and as it sometimes is. The native capacities of mankind vary no less than their opportunities, and while culture is one, the road by which one man may best reach it is widely different from that which is most advantageous to another. . . . But for those who mean to make science their serious occupation, or who intend to follow the profession of medicine, or who have to enter early upon the business of life, for all these, classical education is in my opinion a mistake; and it is for this reason that I am glad to see 'mere literary education and instruction' shut out from the curriculum of Sir Josiah Mason's College, seeing that its inclusion would probably lead to the introduction of the ordinary smattering of Latin and Greek."

The second essay, which is "the Inaugural Address of the Lord Rector of the University of Aberdeen," is

entitled "Universities, Actual and Ideal." Here the leading theme is that an "ideal university" should be open to men of all classes, and be able efficiently to teach all branches of knowledge. "I should like to see Professors of the Fine Arts in every University; and instruction in some part of their work make a part of the Arts curriculum." "If there are Doctors of Music, why should there be no Masters of Painting, of Sculpture, of Architecture?" This is one kind of knowledge; another is "knowledge relating to the scope and limits of the mental faculties of man; a form of knowledge which, in its positive aspect, answers pretty much to Logic, and part of Psychology, while, on its negative and critical side it corresponds with Metaphysics." Yet another class "comprehends all that knowledge which relates to man's welfare, so far as it is determined by his own acts, or what we call his conduct. It answers to Moral and Religious Philosophy." Lastly, there is "knowledge of the phenomena of the universe," or science, mathematical, physical, biological, and social. Concerning the relative importance of these departments of knowledge, substantially the same opinion is expressed as in the previous address: "I am ashamed to repeat here what I have said elsewhere, in season and out of season, respecting the value of science as knowledge and discipline," &c. Concerning the teaching of science, it is shown that the "ideal University" "ought not to be satisfied with mere book-knowledge. . . . If I may paraphrase Hobbes' well-known aphorism, I would say that 'books are the money of literature, but only the counters of science.'" The address next goes on to the question of Medical Education, advocating the abolition of Botany, Zoology, and Comparative Anatomy from the curriculum. Speaking of the study of Physiology, the Lord Rector says—

"Moreover, I would urge that a thorough study of Human Physiology is in itself an education broader and more comprehensive than much that passes under that name. There is no side of the intellect which it does not call into play, no region of human knowledge into which either its roots or its branches do not extend; like the Atlantic between the Old and the New Worlds, its waves mark the shores of the two worlds of matter and of mind; its tributary streams flow from both; through its waters, as yet unfurrowed by the keel of any Columbus, lies the road, if any such there be, from the one to the other; far away from that North-West Passage of mere speculation, in which so many brave souls have been hopelessly frozen up."

In an ideal University it should be recognised that Science has the same right as Theology, Law, or Medicine to a

"Faculty of its own in which men shall be trained to be professional men of science . . . The establishment of such a Faculty would have the additional advantage of providing, in some measure, for one of the greatest wants of our time and country; I mean proper support and endowment of original research. . . . If a student of my own subject shows power and originality, I dare not advise him to adopt a scientific career . . . and I believe the case is as bad, or perhaps worse, with other branches of science. In this respect Britain, whose immense wealth and prosperity hangs on the thread of applied science, is far behind France, and infinitely behind Germany."

On the subject of Examinations Prof. Huxley says:—

"Examination, like fire, is a good servant, but a bad master; and there seems to me to be some danger of its becoming our master. I by no means stand alone in this opinion. Experienced friends of mine do not hesitate to say that students whose career they watch, appear to them to become deteriorated by the constant effort to pass this or that examination, just as we hear of men's brains becoming affected by the daily necessity of catching a train. They work to pass, not to know; and outraged science takes her revenge. They do pass, and they don't know. . . . Under the best of circumstances, I believe that examination will remain but an imperfect test of knowledge, and a still more imperfect test of capacity, while it tells next to nothing about a man's power as an investigator."

While dealing with the desirability of undergraduates having had sufficient instruction at school to profit by the higher education which ought to be provided by a university, Prof. Huxley says:—

"A high authority, himself head of an English college, has solemnly affirmed that: 'Elementary teaching of youths under twenty is now the only function performed by the University'; and that colleges are 'boarding schools in which the elements of the learned languages are taught to youth.' This is not the first time I have quoted these remarkable assertions. I should like to engrave them in public view, for they have not been refuted."

Here we are less surprised at the certainly "remarkable assertions" of the Rector of Lincoln, than by their unqualified endorsement of the Rector of Aberdeen; for if "they have not been refuted" we should suppose that the only reason must be because they are too obviously extravagant to demand refutation. That our English universities have thrown upon them a great deal more work in the way of comparatively elementary education than is either desirable or creditable, and that in consequence a vast amount of money and of teaching power is misappropriately applied, no one can dispute; but to "solemnly affirm" that the *only* function of these universities is that of boarding schools, is unwisely to overstate the evil.

The third essay is on "Technical Education." Delivered before the "Working Men's Club and Institute," it appropriately inculcates—

"The truth that while under-instruction is a bad thing, over-instruction may possibly be a worse. Success in any kind of practical life is not dependent solely, or even chiefly, upon knowledge. Even in the learned professions, knowledge, alone, is of less consequence than people are apt to imagine. And, if much expenditure of bodily energy is involved in the day's work, mere knowledge is of still less importance when weighed against the probable cost of its acquirement."

The ideal of "Technical education for handicraftsmen" held out by Prof. Huxley is that of avoiding excess either of general or of technical instruction for "the great mass of mankind who have neither the liking nor the aptitude for either literary, or scientific, or artistic pursuits," while making provision "to catch exceptional people—the small percentage of the population which is born with that most excellent quality, a desire for excellence, or with special aptitudes of one sort or other. . . . I weigh my words when I say that if the nation could purchase a potential Watt, or Davy, or Faraday, at the cost of a hundred thousand pounds down, he would be dirt-cheap at the money."

Substantially the same views are expressed in the next

essay, which is on "Elementary Instruction in Physiology." Thus—

"The saying that a little knowledge is a dangerous thing is, to my mind, a very dangerous adage. If knowledge is real and genuine I do not believe that it is other than a very valuable possession, however infinitesimal its quantity may be. Indeed, if a little knowledge is dangerous, where is the man who has so much as to be out of danger?"

If the life-long labours of the greatest physiologist of his age—William Harvey—had revealed to him a tenth part of the knowledge which may now be made sound and real to our boys and girls "he would have loomed upon the seventeenth century as a sort of intellectual portent."

The address on "Joseph Priestley" is an exceedingly interesting biographical and historical sketch, and is followed by the essay on "The Method of Zadig," which, from having been so recently published in the *Nineteenth Century*, will be fresh in the memory of most readers.

The lecture on "The Border Territory between the Animal and the Vegetable Kingdoms" was delivered at the Royal Institution in January, 1876, and is a masterly piece of biological exposition, which "tends to the conclusion that the difference between animal and plant is one of degree rather than of kind; and that the problem whether, in a given case, an organism is an animal or a plant, may be essentially insoluble."

The essay "On certain Errors respecting the Structure of the Heart attributed to Aristotle," having been originally published in NATURE (vol. xxi. p. 1) need not detain us now; we shall therefore pass on to the next in the series, and the one which has excited more interest and discussion than any of the others. This is the Evening Lecture before the British Association in 1874, "On the Hypothesis that Animals are Conscious Automata;" and both as regards the interest of its subject-matter and the logical precision with which the argument is stated, we think that it deserves to be considered the most important essay in the series.

It is now universally known what the argument is, and how with irrefragable sequence it leads us to the conclusion that—

"Consciousness would appear to be related to the mechanism of the body simply as a collateral product of its working, and to be as completely without any power of modifying that working as the steam-whistle which accompanies the work of a locomotive engine is without influence upon its machinery."

There can be no doubt that the logic by which this conclusion is reached is everywhere intact; but there is one important criticism to which the "hypothesis" in question is open, and which, as it has not we believe been hitherto clearly advanced, we may briefly state.

The hypothesis rests on the fact that there is a constant parallelism between cerebral processes and mental processes, and as this fact cannot be attributed to accident and is not attributed by the hypothesis of automatism to any pre-established harmony, there remains only the supposition that the true processes are in some way intimately associated. Some intimate association between neurosis and psychosis being thus accepted as a fact by the hypothesis of automatism, the whole question which this hypothesis raises may be briefly put thus:—If the stream of mental activity were withdrawn, could the stream of cerebral activity with which it is now associated continue in exactly the same way, or could it not? In other words, is the constant relation which now subsists between the two processes necessary or unnecessary to the occurrence of the latter? The hypothesis of automatism virtually answers that the relation is unnecessary, and this on the ground of its being inconceivable that it should be necessary. But now let us ask, Is it any more conceivable that this relation should be unnecessary? Certainly not, because the inconceivability resides in the fact of there being *some* relation, and is not affected whether we choose to regard the *character* of this relation as necessary or unnecessary. We may try in thought to refine this relation, and to re-refine it again and again, until we conceive of mental processes as mere indices of corresponding neural processes; but so long as we accept the belief that there is *any one point of contact* between these two sets of processes, so long are we in the presence of just the same difficulty as when we started. Having driven the soul into some minute pineal gland of unnecessary relation, we find after all that we have gained nothing on the side of conceivability; we find it is no more easy to understand the soul as located in this little gland of unnecessary relation, than to understand it as distributed over the whole brain-work of intimate and necessary relation. The hypothesis of automatism would thus appear to contain the elements of its own destruction. For while accepting a fact which renders either the affirmation or the negation of the hypothesis alike inconceivable—viz. the fact of there being *a* connection between neurosis and psychosis—it nevertheless proceeds to choose one of these alternatives in preference to the other; and this on the sole ground of inconceivability.

Of course in advancing this criticism we are not ourselves arguing for any theory. We are merely observing that as in the theory of automatism there is, *ex hypothesi*, *some* connection between neurosis and psychosis which is of a nature not merely unknown but inconceivable, the theory can have no right to affirm, or even to infer, that this connection is unnecessary; and common sense will, therefore, have as much reason as ever to disbelieve that if consciousness had never appeared upon the scene of life, railway trains would now have been running filled with mindless passengers, and telephones would have been invented by brains that could not think, to speak to ears that could not hear. Thus, until it is shown who or what it is that blows the whistle of consciousness in the simile of the steam-engine, we must conclude that the hypothesis of conscious automatism is nothing more than an emphatic re-statement of the truth, that the relation between body and mind is a relation which has so far proved inconceivable.[1]

Essay X. is on "Sensation and the Unity of Structure of Sensiferous Organs." It presents a *résumé* of some of the older theories of sensation, and a clear statement of the modern generalisation that "whatever be the apparent diversities among the sensiferous apparatus, they share certain common characters," &c.

[1] It is no answer to say that the *brain* blows this whistle, for even if a causal relation is assumed, it is no more *conceivable* that this should extend from neurosis to psychosis than that it should extend from psychosis to neurosis.

"Evolution in Biology" is an entertaining history of the contest between the theories of Epigenesis and Metamorphosis, passing on to a brief account of the facts relating to the "Evolution of the Individual" as brought to light by modern embryology, and of the "Evolution of the Sum of Living Beings," as previously taught by the older theorists, and as now taught by a conjunction of the sciences.

On the two addresses that remain it is needless to comment, as one of them—viz. that which was delivered before the International Medical Congress in August last—must be well within the recollection of our readers, and the other "On the Coming of Age of the 'Origin of Species,'" has already been printed in these columns (1880). We may, however, fitly conclude our necessarily inadequate review of so much admirable writing by again printing the beautiful peroration of this address.

"I venture to repeat what I have said before, that, so far as the animal world is concerned, evolution is no longer a speculation, but a statement of historical fact. It takes its place alongside of those accepted truths which must be reckoned with by philosophers of all Schools. Thus when, on the first day of October next, the 'Origin of Species' comes of age, the promise of its youth will be amply fulfilled; and we shall be prepared to congratulate the venerated author of the book, not only that the greatness of his achievement and its enduring influence upon the progress of knowledge have won him a place beside our Harvey; but, still more, that, like Harvey, he has lived long enough to outlast detraction and opposition, and to see the stone that the builders rejected become the head-stone of the corner."

GEORGE J. ROMANES

OUR BOOK SHELF

Proceedings of the London Mathematical Society, vol. xii. (November 11, 1880–November 10, 1881).

THE papers in this volume, as usual, are mostly purely analytical in their character. Prof. Cayley's contributions are very short: the binomial equation $x^p - 1 = 0$; quinquisection; on the flexure and equilibrium of a skew surface; on the geodesic curvature of a curve on a surface, and on the Gaussian theory of surfaces. Sir J. Cockle continues his remarks on binomial biordinals. Mr. Glaisher's papers are also few and short, viz. on some definite integrals expressible in terms of the first complete definite integral, and of gamma-functions; note on certain symbolic operators and their application to the solution of certain partial differential equations. Messrs. Crofton and J. J. Walker have some points of contact, the former writing on operative symbols in the differential calculus, the latter continuing his theorems in the calculus of operations. Mr. Walker also contributes a quaternion proof of a problem discussed by Mr. S. Roberts, viz. certain tetrahedra specially related to four spheres meeting in a point. Mr. Roberts also gives a historical note on Dr. Graves's theorem on confocal conics." Mr. W. R. W. Roberts has a paper on the periods of the first class of hyper-elliptic integrals, and a note on the coordinates of a tangent line to the curve of intersection of two quadrics. Mr. T. Craig has a note on Abel's theorem. Papers bearing on geometry are contributed by Prof. Genese, on a system of co-ordinates; by Mr. H. Hart, on the general equation of the second degree in tetrahedral co-ordinates; by Mr. H. M. Jeffery, on bicircular quartics, with a triple and a double focus, and three single foci, all of them collinear; and on spherical quartics, with a quadruple cyclic arc and a triple focus; by Prof. Mannheim, sur les surfaces parallèles; by Mr. R. A. Roberts, on the tangents drawn from a point to a nodal cubic; and note on a system of cartesian ovals, passing through four points on a circle. Signor Brioschi writes sur une propriété du paramètre de la transformée canonique des formes cubiques ternaires; and Mr. Carpmael renews an old discussion in his some solutions of Kirkman's 15-school-girl problem. The subject of kinematics on a sphere is ably treated by Mr. E. B. Elliott. Mr. Routh contributes some applications of conjugate functions, and Mr. W. D. Niven writes on the electrical capacity of a conductor bounded by two spherical surfaces cutting at any angle. The presidential address is by Mr. C. W. Merrifield, and is entitled "Considerations respecting the Translation of Series of Observations into Continuous Formulæ." We have sketched out a bill of fare appealing to many diverse tastes, and we can assure our readers that the dishes are all of admirable quality.

Jornal de Sciencias Mathematicas e Astronomicas. Publicado pelo Dr. Francisco Gomes Teixeira. (Coimbra, 1881.)

WE have received the first two volumes of this work and the five opening numbers of the third volume. It is a matter of considerable interest to see what a place scientific writings and mathematical works are taking in the Peninsula. The journal before us is apparently not at all ambitious in its aims, but seeks to bring before the students such articles as might perhaps find a place in our own *Messenger of Mathematics*. A fault we have to find with the single numbers is that they have no index of contents, and further, they are unstitched. We wish Prof. Gomes Teixeira every success in his venture.

Philosophische Studien herausgegeben. Von Wilhelm Wundt. Bd. 1 Heft 1. (Leipzig: W. Engelmann, 1881.)

IN the *Philosophische Studien* we have the first instalment of a new periodical conducted by Wilhelm Wundt, which bids fair to attract a wide circle of readers not deterred by close, hard reasoning. It contains four articles:—(1) *On psychological methods*, by the editor; in three sections treating of the psychophysical methods, methods of analysis of the sense-perception, and of psychological measurement of time; (2) *On the length of time in the apperception of simple and compound ideas* (*colours* and *numbers*), by Dr. Max Friedrich; an essay which no doubt owes a great deal also to the editor, and containing the results of some remarkable experiments on the above phenomena; (3) *Investigations on the sense of time*, by Julius Kollert, in continuation of Vierordt's experiments on the same subject; (4) *On mathematical induction*, by the editor, under the heads of "analytical and synthetic methods in mathematics," "the question of the origin of mathematical principles," "experimental beginnings of mathematics," "permanent forms of mathematical induction," "mathematical abstraction," and "exact analogy." The spirit and methods of the editor permeate the whole of this first number, and guarantee the value of the periodical.

Biologische Probleme, zugleich als Versuch einer rationellen Ethik. Von W. H. Rolph. (Leipzig: W. Engelmann, 1881).

ORIGINALLY intended as a criticism on the customary methods of ethics, especially Herbert Spencer's "Data of Ethics," the present work has assumed a wider scope, and embraces the treatment of a number of biological problems, which the author has endeavoured to connect with a view to solution on a common basis. Its aim may be best exhibited in the following enumeration of the subjects discussed:—viz. the doctrine of evolution, subjective systems (Mallock, Spencer, Miss Bevington); H. Spencer's Hedonism; theory of nourishment (hunger the first motive to action, p. 53); theory of development

(abundance of suitable nourishment the primary condition); theory of propagation; animal ethics; and lastly, human ethics.

Abriss der Zoologie für Studirende, Ärzte und Lehrer. Von Dr. A. Brass. (Leipzig: W. Engelmann, 1882.)

In this octavo volume of over 360 pages we have a sketch of the modern aspect of zoology fairly well executed, and with woodcut illustrations after Frey, Hæckel, Kölliker, and Gegenbaur. The first section treats of zoology in general, discusses the subject of the differences between the animal and vegetable kingdoms, and considers the animal in general. The second section is devoted to the morphology and developmental history of animals. The third is the systematic portion. The classification adopted is for the most part a copy of Claus's. The volume forms a handy compendium of zoological science, and, like all the works from the establishment of the well-known Leipzig publisher, is well printed on good paper.

The Two Hemispheres: A Popular Account of the Countries and Peoples of the World. By G. G. Chisholm, M.A. Illustrations. (London: Blackie and Son, 1882.)

This work contains in one volume much useful geographical information, methodically arranged. It is, indeed, a systematic and succinct account of the various continents, countries, and oceans, somewhat after the style of a gazetteer, for which it may be used by means of the copious index. The information seems to us in the main accurate, though many of the illustrations appear well worn. Mr. Chisholm, however, gives the old erroneous measurements of Mounts St. Elias and Fairweather, in Alaska, evidently unaware of the survey made by Dall six years ago, and which showed them to be 4000 feet higher than given here.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Sun-spots

The spot seen on the sun by Mr. W. A. Holland (Nature, vol. xxv. p. 316) would appear to have been simply a large sun-spot which made its appearance at the sun's east limb on November 15, and went off the disk on November 27. It is shown on photographs taken at Greenwich on November 16, 17, 18, 19, 20, 21, 23, 26, and 27. On November 21, 11h. a.m. it was north-east of the centre, Pos-angle 50° 27′, Dist. 0·188 of sun's radius, and on November 23 0h. it was north-west of the centre Pos-angle 313° 39′ dist. 0·412. The estimate of its size by Mr. Holland is very much exaggerated, the dimensions of the whole spot (nucleus and penumbra), as measured on the photographs, being one-twentieth of the sun's diameter in length, and one-twenty-fifth in breadth. The area, corrected for foreshortening and expressed in millionths of the sun's visible hemisphere, was 832 for the whole spot, and 152 for the nucleus on November 21, and 970 for the whole spot, and 171 for the nucleus on November 23. The spot had begun to break up between November 21 and 23, and the area for November 21 is really the largest as applying to a single undivided spot. This spot is one of the largest yet recorded at Greenwich. Two other large spots of about the same size were photographed in 1881, on March 22 and June 1, their areas being respectively 919 for the whole spot, and 195 for the nucleus; and 931 for the whole spot, and 158 for the nucleus. The next largest spot in previous years was that of 1877 November, with an area of 801 for the whole spot, and 109 for the nucleus.

While on the subject of sun-spots, I may mention with reference to Mr. J. B. N. Hennessey's letters on an Outburst of Sun Spots (Nature, vol. xxiv. p. 508, and vol. xxv. p. 241) that a photograph taken at Greenwich, 1881, July, 24d 23h. 11m. 10s., G.M.T., only 11m. before the new group was noticed on the ground-glass at Dehra Doon, shows no indication whatever of the group in question, and that no trace of it appears on a photograph taken next morning, July 25, 22h. 17m. 55s. G.M.T. Thus the new group, if real, must have formed suddenly in less than eleven minutes at a part of the sun's surface where there was not the slightest previous disturbance of the photosphere, and must have completely disappeared within the space of 23h. It might have been expected that the granules of the photosphere, which are well defined in the Greenwich photographs referred to, would have given some indication of such an outburst.

W. H. M. Christie

Royal Observatory, Greenwich, February 6

The importance attached to the solar observations of Mr. W. A. Holland by so great an authority as Sir W. Thomson, would alone suffice to warrant me in forwarding for your publication exact drawings of the spots observed on November 22 and 23 of last year, and the wording of the letters of Mr. Holland makes it still more urgent to determine the precise extent of the spots in question.

The small optical power used on November 22 and 23, on board the *Sarah Bell*, places the result almost on a level with direct eye observations, and the description strongly recalls to mind the accounts given of solar spots previous to the discovery of the telescope. Thus on November 22 we have two eye-estimates of the size of the spot. "I, myself," writes Mr. H., "estimated the spot on the sun to be $\frac{1}{6}$ diam., but conferring with the captain, he estimated it to be $\frac{1}{8}$ diam.; it was purely an estimate of the eye."

The pictures of the sun, which I inclose, were taken at Stonyhurst Observatory on November 20 and 22, and they give an exact outline of the spot seen on board the *Sarah Bell*, clearly showing what meaning we may reasonably attach to those ancient carefully denoted sun-spots, which were said to have a diameter equal to $\frac{1}{4}$, $\frac{1}{3}$, or even $\frac{1}{2}$ of the solar disk. The length of the spot observed on November 22 agrees very fairly with Mr. H.'s approximate estimate, if we include the whole group, but this gives a very incorrect notion of the spot-area, and of the disturbing forces then apparently at work in the sun.

From accurate measurements of the original drawings, which give the relative dimensions of the spots on the solar disk, I find the diameter of the sun to be 267 mm., the length of the group 54 mm., and its breadth 22 mm., whilst the length of the large spot, including its whole penumbra, is only 15 mm. The group is a scattered one, and the whole spot area in the picture can scarcely exceed 225 sq. mm., and therefore, being situated almost at the centre of the disk, will not cover more than one thousandth part of the visible hemispheres, although the whole group is spread over a space nearly five times as large. We thus get a more correct notion of the disturbance on the solar surface than by measuring merely the diameter of the group, or by expressing the spot area in millions of square miles.

The drawing of November 22 contains another spot in the *n.p.* quadrant, which is not mentioned by Mr. Holland, but which a few days previously, when nearer the centre of the disk, was as conspicuous an object as the spot under discussion, and was easily seen by the naked eye on November 18, shortly after sunrise. The group which followed was then near the limb, and was a fine object in a small binocular, but not visible to the naked eye.

The fact of two separate spots, each seen easily without a telescope, being on different portions of the solar disk at the same time is, I think, rather extraordinary, but the area covered by spots has never approached of late to what was sketched by Tacchini in 1871, or even what was photographed by Rutherfurd in 1870. I might perhaps also mention that the spot which crossed the disk in May and June was as large as that of November.

S. J. Perry

Stonyhurst Observatory, Whalley, February 5

[The drawings sent by Mr. Perry seem to us to quite bear out his statements.—Ed.]

Rime Cloud observed in a Balloon

A singular phenomenon was observed in Paris in the month of January. An obscure cloud remained in a state of suspen-

sion over Paris and a large tract of the country from the 4th up to the 26th, without any intermission. Neither sun, nor stars, nor moon were visible for an instant during that lengthened period.

The prevailing opinion among meteorologists was that the nebulosity was formed by a mass of snow suspended in the atmosphere.

Although the notion was generally accepted, I opposed it, in my contributions to *L'Electricité*, remarking that if such were the case, snow or at least water should have fallen in Paris and vicinity where the dryness was complete from the apparition of this remarkable nebulosity. But being unable to settle the controversy without actual observation, I ascended in a balloon from La Villette Gas Works on January 25 at 2h. 35. p.m. I found my anticipations were quite correct, as not a single flake of snow was seen by me or by M. Anatole Brissonet, a young gentleman who was assisting me by manœuvring the balloon. But I was quite deceived in the thickness of the cloud, which did not exceed 300 metres, although it rendered the sun perfectly invisible, and I had written it ought to be numbered by thousands.

The earth was lost sight of gradually, and was perfectly invisible at 270 metres, but the sun was shining in all its glory at 580 metres, with blue sky. The cloud was not so blinding as usual when it is composed of condensed vapour, as the thermometer and barometer could be read with perfect accuracy in the centre of it, and the lower part of the balloon was entirely visible at a distance of about 4 or 5 metres, but the equator was lost in whitish smoke perfectly impenetrable to sight. This nebulous matter appeared perfectly homogeneous, and I could see no trace of any crystalline matter, but an unexpected observation proved that it was formed of minute solidified atoms of water in a real microscopic state of division.

When we emerged from the cloud gently and slowly, I stop the throwing out of any ballast in order to remain in close vicinity of its surface. M. Brissonet and I observed carefully what was occurring around us. The heating effect of the sun was in some respect destroyed by the radiation towards the cloud, which was at a temperature of 5° C. So we were floating at a level almost perfectly equal, in an air at a temperature from $-2°$ to $-3°$. The air at the surface of the clouds was perfectly calm, but at a few metres upwards it was moving north-north-easterly at a rate of eight miles an hour. The consequence was that we were towed by the globe, and feeling keenly a cold current sweeping over our faces. We had uncoiled our guide rope, the length of which was 60 metres, and the end of which was consequently immersed in the cloud and dragged into it. To our intense surprise, and I may say delight, we perceived that this part was quite loaded with hoar frost, which had precipitated regularly by series of hairs a few millimetres long. These accumulations during a sweep which lasted for an hour, and a distance of about eight miles, are consistent with the fact previously stated, that no deposit was visible during our ascent, which had been very slow indeed. My calculations show that our vertical velocity was not exceeding 30 metres per minute, which is only one-eighth of our horizontal velocity, continued during six times longer. In our descent, which was rather quicker, but not to a great degree, the sweeping may have accumulated the frost rime on the bottom of the car, which it could not have been easy to observe, and consequently I cannot state what occurred, but not a single crystal was deposited on our ropes during that period.

I have been unable to procure Scoresby's Sketches of the Polar Regions, but only a review by Arago, who says (ix. p. 357, 10, *et seq.*): The "*frost-rime* ou fumée-gelée est un phénomène particulier des ces regions de la terre ou le froid est de longue durée, dont une vapeur dense [1] qui est dans un état complet de congélation. . . . Les parties extrémement deliées dont le *frost-rime* se compose s'attachent à tous les corps vers lesquels le vent les pousse, et y forment quelque fois une croûte de plus de 3 centimètres d'epaisseur, herisse de longues files prismatiques, on pyramidales la pointe dirigée du côté du vent."

It seems to me that the constitution of cirrus clouds seems to be explained by these properties of *frost-rime* clouds. These minute crystals, which can remain for an indefinite period suspended in the air, are, properly speaking, the *materies nivei*, but not *nives ipsa*. It is by motion, either vertical or horizontal, that they are changed either into hoar-frost or snow, according to circumstances.

W. DE FONVIELLE

[1] I suppose that Scoresby is speaking of optical density.

Researches on Animals containing Chlorophyll

MR. PATRICK GEDDES appears to have been anticipated in most of the points set forth in his paper on Further Researches on Animals containing Chlorophyll, published in NATURE of January 26 last, by Dr. Brandt, of Berlin, who, in a paper read before the Physiological Society of Berlin on November 11 last, and published in the *Proceedings* of the Society on the "Symbiosis of Lower Animals with Algæ," describes the cultivation, after removal from the bodies of the various animals affected by them, of the well-known yellow and green chlorophyll-containing bodies, their development of starch grains, and their successful artificial implantation into the bodies of fresh hosts previously free from them; this latter being an important fact apparently not known to Mr. Geddes. Dr. Brandt further names the species of algæ in question under two genera, Zoochlorella and Zooxanthella, and gives to the peculiar physiological relations of mutual advantage between the plants and animals the term "symbiosis." Mr. Geddes appears not to have seen this paper of Dr. Brandt, since he merely refers to some of his earlier papers on the same subject, but it is important. Dr. Brandt's claims in the matter should not pass without notice in NATURE. I have not seen Dr. Brandt's original paper, but only an abstract published in the *Naturforscher* of January 14 last, from which I take the information given above.

H. N. MOSELEY

The Movements of Jupiter's Atmosphere

IN NATURE, vol. xxv. p. 213, Mr. Darwin describes the bands on Jupiter as "due to the trades and anti-trades" set in motion by the action of solar radiation on the solid body of the planet as are the trade winds of the earth. Many other eminent astronomers still appear to accept this time-honoured explanation of the phenomena.

Have they reflected on the revelations supplied by the low specific gravity of Jupiter? There is no form of matter with which we are acquainted that could exist at a mean density of about one-fourth of that of the earth, while subject to the enormous pressure due to the mass of Jupiter, unless it were sufficiently hot to render the formation of a solid crust on its surface quite impossible. In order to attribute terrestrial solidity to either Jupiter, Saturn, Uranus, or Neptune we must invent a new kind of matter as infusible as platinum, and far lighter than hydrogen, or endow it with absolute incompressibility.

These planets, if composed of any of the chemical elements or compounds known to us, can only retain their low density under the enormous pressure of their masses by the agency of proportionately counteracting heat-repulsion. At and about their centres this may be so far overcome by the superincumbent pressure as to produce solid nuclei, but these must be very small in proportion to the mass of the planet.

Assuming the existence of such a central nucleus of Jupiter surrounded by a great fluid envelope, how will it be affected by the gravitating reaction of the satellite, supposing the compression to give it a specific gravity exceeding the mean specific gravity of its envelope?

It will obviously perform an eccentric rotation, or reeling, within the envelope. This motion must be very irregular and complex, owing to the different periods and the varying relative positions of the satellites; but the varying resultant of their gravitation forces will have one element of constancy, viz. a close coincidence with the plane of the planet's equator.

The effect of such internal reeling upon the surrounding gaseous mass explains far more efficiently than any possibility of solar radiation, the disturbances indicated by the ever-changing belts and spots of this planet; and also the greater rotatory velocity of the equatorial spots, described by Mr. Denning in the above-named number of NATURE, p. 225.

The correspondence of these with the varieties of rotation of the different parts of the solar surface observed by Carrington, is well worthy of note, and admit of similar explanation; planetary reaction in the case of the sun taking the place of the satellite reaction on Jupiter. In my essay on "The Fuel of the Sun" I have worked out other consequences of this reeling of the solar nucleus and their analogues in the greater planets.

Stonebridge Park, January 26 W. MATTIEU WILLIAMS

"The Lepidoptera of Ceylon"

MR. F. MOORE in no way betters the case against him by his letter printed in NATURE, vol. xxv. p. 79. The name of George

de Alwis, who was merely employed to make accurate copies of his brother's drawings, need not be brought forward; Mr. Moore was perfectly aware who made the original drawings from nature. It is satisfactory to know that the preface will contain an acknowledgment of the real artist, but common honesty requires his name to be printed on every plate that he drew instead of "C. F. Moore." HENRY TRIMEN

R. Bot. Gardens, Peradeniya, Ceylon, January 9

The Collection of Meteoric Dust—A Suggestion

IN the Report of the Committee on Meteoric Dust, given in your report of the last meeting of the British Association (NATURE, vol. xxiv. p. 462), Prof. Schuster refers to the difficulty "found in the determination of the locality in which the observations should be conducted," as there are but few accessible places sufficiently sheltered "against any ordinary dust not of meteoric origin. The lonely spots best suited for these observations are generally accessible to occasional experiments only, and do not lend themselves easily to a regular series of observations." As it is highly important that such a regular series should be obtained, and that such observations should be made in places "sheltered as much as possible" from dust of terrestrial origin, I venture to think that these conditions would be complied with by employing suitably constructed *captive balloons*, carrying the collecting apparatus at the highest attainable altitude. By this means we should have the great advantage of not only making the experiments abroad, but the observations might also be made from some hill-top in the north of Scotland, sufficiently far from any manufacturing town to insure the necessary freedom from dust of terrestrial origin. B. J. HOPKINS

79, Marlborough Road, Dalston, E.

Colour and Sound

SOME weeks ago there appeared an account of a series of experiments connecting colour and sound; the following passage from Prof. Max Müller's Chips, ii. 104, may interest some of your readers:—"That Purûravas is an appropriate name of a solar hero requires hardly any proof. Purûravas meant the same as πολυδευκής, endowed with much light; for though rava is generally used of sound, yet the root ru, which means originally to cry, is also applied to colour, in the sense of a loud or crying colour, *i.e.* red (cf. ruber, rufus, Lith, rauda, O.H.G. rôt, rudhira, ἐρυθρός; also Sanskrit ravi, sun)." The following footnote occurs:—"Thus it is said, Rv. vi. 3, 6, the fire cries with light, *sok*ishâ ıârapîti; the two Spartan Charites are called Κλητά (κλητά, incluta) and Φαεννά, *i.e.* Clara, clear-shining. In the Veda the rising sun is said to cry like a new child (Rv. ix. 74, 1)—I do not derive ravas from rap, but I only quote rap as illustrating the close connection between loudness of sound and brightness of light."

Both Greeks and Latins seem to have used the same words for colour and sound, cf. λαμπρός, λευκός, μέλας, σομφός, φαιός, &c.; clarus, fuscus, candidus, &c. Probably not only colour and sound, but smell, taste, and touch had in early times the like words to express degree; even as we find aspera lingua and odor asper; and as we say "a harsh taste" and "a harsh sound." Tastes and smells will be found to suggest colours to the mind exactly as sounds do. If this be so, may not this apparently curious connection be explained as a sort of "*unconscious* philological memory?" KARL PEARSON

Inner Temple, January 28

On the Climate of North Northumberland as Regards its Fitness for Astronomical Observations

A LETTER in the last issue of NATURE (p. 317) upon the above subject, not altogether agreeing with the published records of this station, I should like to ask the reverend gentleman whether his observations were taken promiscuously; at stated times, or extending from sunset to sunrise. As the summary does not "tally" with the "weather at time" or "weather since taken" *without a break* during 1881 at 6 p.m. and 9 a.m. daily, I am afraid that a misconception will be formed as to the weather here by the readers of NATURE, and as this station is about 300 yards from Mr. Perry's observatory, there must be a mistake upon one side or the other, or probably the astronomical and meteorological definitions of "completely overcast" are different. JOSEPH LINGWOOD

Meteorological Society's Station, Alnwick, February 4

Parhelia in the Mediterranean

ON the morning of the 27th inst. a curious sight was witnessed at this place. I was sailing on the Mediterranean, and the day was hot and sunny. A slight haze came on, and about noon a large halo with an orange tint surrounded the sun. Shortly afterwards two mock suns appeared, one on each side of the ring round the central sun. They were also tinged with an orange colour, and appeared to have comet-like tails. Reflected in the still blue water they were even more distinct than when looked at direct, as the water cut off the sun's rays. This singular spectacle lasted more than an hour, and was seen by many. The boatmen predicted bad weather, but it has not yet come. All through January we have had brilliant summer days, with cold starlight nights—the minimum thermometer descending to 38° and 36° almost every night. I send you a very rough sketch of the mock suns. CHAS. H. ALLEN

Mentone, Alpes Maritimes, January

SIR ROBERT CHRISTISON

NOTWITHSTANDING his advanced age, the announcement of the death of Sir Robert Christison will be received with universal regret. He died on January 27, from the effects of a cold caught a month previously. Sir Robert's father was for many years Professor of Humanity in the University of Edinburgh, where the son was born on July 18, 1797. He attended first the High School, and subsequently the Arts Classes at the University. Having been well grounded in literature and general science, he turned his attention to medical studies, and graduated as Doctor of Medicine in 1819. Proceeding to the schools of London and Paris, in the latter city he became a pupil of Robiquet, the eminent chemist and *pharmacien*, in whose laboratory he worked assiduously, and, as he used often to say in after life, with signal advantage. Here, too, he is understood to have prosecuted, under the celebrated Orfila, that study of toxicology to which he had all along shown a special bent, and in which he was destined to achieve so important results. Shortly after his return to Edinburgh the young physician was, in 1822, appointed to the University Chair of Medical Jurisprudence, in succession to Dr. Alison. This post he occupied till 1832, when he relinquished it to assume the Chair of Materia Medica, rendered vacant by the death of Dr. A. Duncan, and for the clinical duties of which he was well qualified by hospital practice; while for its general work he had been thoroughly equipped by those old studies under Robiquet, followed up, in the interval, by diligent examination of every fresh pharmaceutical discovery.

Dr. Christison was able to give to the science of Medical Jurisprudence a precision it had formerly lacked, and thus contributed in no small degree to its practical development. Very important in this connection was the publication, in 1829, of his "Treatise on Poisons," which was received at the time by physicians, jurists, and men of science generally, as the most philosophical exposition of the subject that had ever appeared, and is even now regarded as a work of great value. From his position as Professor of Medical Jurisprudence, Dr. Christison was naturally called upon to act as an expert in criminal trials; and it was not long before his appearances in that capacity secured for him the reputation of a highly important witness.

In exchanging the Chair of Medical Jurisprudence for that of Materia Medica, Dr. Christison was, so to speak, confirmed in that line of chemical research for which he had all along shown special predilection. In the laboratory he was noted as a peculiarly neat and clean worker—a qualification of the utmost importance in prosecuting, for example, delicate toxological experiments. Nor was his exactitude greater than the earnestness and enthusiasm with which he followed out any inquiry to its ultimate issues. The well-known case of the Calabar bean,

in which an experiment on his own person was only prevented from proving fatal by timely swallowing of his shaving water, was a significant indication of the thoroughgoing spirit in which all his researches were pursued. As a *pharmacien* he rendered valuable service to the profession in connection with the last edition of the "Edinburgh Pharmacopœia," merged since 1864, like those of London and Dublin, in the "Pharmacopœia Britannica," prepared under the auspices of the General Medical Council; and in his "Dispensatory," published in 1842 (second edition. 1848), he presented a commentary on the then existing Pharmacopœias, characterised, like his book on Poisons, by precision in details, and by the concise, yet happy expression of suggestive generalisations.

In the professorial chair Dr. Christison proved a singularly lucid and instructive lecturer. Himself strictly methodical in everything pertaining to scientific inquiry or professional routine, he fostered in his students habits of exact and well-regulated work. As the result of his incumbency, both the chairs he occupied gained no inconsiderable accession of usefulness and importance; while to that of Materia Medica he left a substantial legacy in the splendid museum, whose riches can never be appreciated till it is properly displayed in the new Medical School. By his students he was loved as well as admired; and once and again, in the course of his long career, old pupils scattered far and wide as busy practitioners, have shown themselves prompt to embrace every opportunity of doing him honour.

As a member of the Senatus Academicus, and Assessor for that body in the University Court—an office to which he was elected five times in succession—Prof. Christison took an active and prominent part in the management of college affairs. No member of the University was more energetic in pushing forward that great scheme of extension which, as now all but realised in a new Medical School, alongside of the new Infirmary, will doubtless raise Edinburgh to a yet higher position as a seat of medical education. The movement for better endowment of the University also found a warm supporter in one who was ever ready to advance what he believed to be the true interests of learning. An ardent lover of all manly exercises, the doctor was himself noted, in his youth, as the most accomplished athlete in the University. A story is told of his having, on one occasion, accomplished the rarely equalled feat of running from the College gate to the top of Arthur seat within twenty-five minutes. In after years, athleticism would often form part of the diversions with which the Professor and his friends relieved the cares of professional life. Even as an octogenarian the vivacious Professor continued to be remarked for the almost jaunty elasticity of his step.

By the Edinburgh Medical Faculty his eminence was duly recognised in his election on two distinct occasions—in 1838, and again in 1846—to the presidentship of the Royal College of Physicians, an honour which was fitly followed up by the Fellows according a place in their hall to his portrait by Sir John Watson Gordon. On the death of Sir David Brewster, he was elected president of the Edinburgh Royal Society; and in this office, held from 1868 to 1873, as well as in the vice-presidentship, which he had formerly filled, he acquitted himself with a distinction which the Society acknowledged by adding his portrait to their gallery of illustrious men. Assiduous in his attendance at the Society's meetings, Dr. Christison from time to time contributed papers to the *Transactions*. Among the subjects thus discussed may be mentioned that of fossil plants in the coal formation, and the remains of ancient trees found in Craigleith and other quarries, on the study of which he brought to bear the resources of chemical analysis. In 1857 Dr. Christison's position among Scotch physicians was fitly recognised in his being nominated by the Crown to represent the profession in Scotland at the General Medical Council. After having for many years held the honorary office of a Physician in Ordinary to the Queen for Scotland, Prof. Christison in 1871 was created a baronet of the United Kingdom, a distinction which was conferred on the recommendation of the then Prime Minister, Mr. Gladstone. In 1873 he celebrated the jubilee of his professorship, an occasion of which friends and admirers were eager to take advantage for testifying their appreciation of the veteran physician. In 1875 he presided over the Edinburgh meeting of the British Medical Association. The veteran's general standing as a scientific man was no less unmistakably certified in his being selected, in 1876, for the presidentship of the British Association for the Advancement of Science: though this honour, in deference to the advice of friends, who feared the effort might overtax his strength, he felt constrained to decline. It was not many months later that an illness, by which he was for a time completely prostrated, led to his resignation of professorial duty.

Sir Robert Christison was married in 1827 to Henrietta Sophia, daughter of Mr. David Brown, of Greenknowe, Stirlingshire. Mrs. Christison died in 1849; but there survive three sons, of whom Alexander, the eldest, born in 1828, was educated at the Edinburgh Academy and High School, and after serving in various capacities, is now Deputy Surgeon-General of the Bengal Army.

CONCERNING THE GAS-FLAME, ELECTRIC, AND SOLAR SPECTRA, AND THEIR EFFECTS ON THE EYE

THE spectra of the light from these various sources is a subject to which I gave some attention about two years ago, and a detailed account of my experiments may be found in the *Proceedings* of the American Academy of Sciences for 1880, p. 236. In this article it was shown that the colour of the sun was not what the average person would call white, but decidedly bluish. The sun's "golden glare" spoken of by Mr. Capron is entirely a subjective effect (except when near the horizon); and follows from the well-known law that bright lights tend to look yellow, and faint ones blue. If the highly magnified images of two diaphragms *equally* illuminated, one by the electric light and one by the sun, be cast upon a screen, the distinctly bluish character of the latter will be strongly marked. Indeed, the magnesium light is more blue than the electric, and hence probably is of a higher temperature, although being spread through a larger space, has less available heating power. As far as mere colour is concerned then, the electric light approaches nearer to the sun than does the gas-flame.

From subsequent experiments, however, it is my impression that colour has nothing whatever to do with the painful effects sometimes noticed in the eyes, after long and continuous work by artificial light. To test this question, I had a tin lamp-shade constructed, consisting of a tube six inches in diameter by eight in length. One end was closed by a reflector, and the other by a piece of very light blue glass. Two holes were made in the sides, through which passed the glass chimney of an Argand gas-burner. By experimenting with a shadow photometer, a position was found where the light received on a book was of the same intensity, and very similar colour, to that from a window in the daytime, at a distance of about six feet. A few minutes' reading, however, was sufficient to convince me that the new light was far more trying to the eyes than an ordinary gas-flame would be. The ill-effects being due to the intense heat thrown down by the reflector. And this I think is the source of the whole trouble in the ordinary gas-burner. The heat radiated by the flame, the heated chimney and shade, and reflected

from the printed page, and all other white paper lying on the table, dries the eyes, the lids, the forehead, and temples, Temporary relief may be found by bathing the face and eyes in water, but it is only temporary. The hot, dry air about the lamp is also harmful, and no doubt contributes its share of injury to the vision. These evils may both in part be remedied by placing a pane of glass so as to intercept the rays from the lamp before they strike on the book or the face. But it must be placed at such a distance from the lamp as not itself to become heated.

The hotter the flame, the whiter it is, and the more light is thrown off in proportion to the heat. Hence oculists are recommending such lights as the Student's and Moderator lamps, which burn with a small, hot, and very brilliant flame, as compared with that furnished by the Argand and fish-tail burners. We learn from statistics how alarmingly prevalent near-sightedness has become of late among students. Hence anything which will tend in the future to prevent this wide-spread defect will be a boon to mankind. And here is where the particular advantages of electricity come to the front. The fact that there are no gaseous products to radiate heat without light, taken together with the high temperature of the incandescent carbon, unite to give us the maximum of light with the minimum of heat. The ever-varying intensity of the arc light is at present a strong objection to it, but we may look forward to the success of the light from the incandescent carbon strip, in the near future, with the assurance that we shall soon have a remedy for the most wide-spread evil that afflicts the human vision.

Boston, Mass., U.S.A. W. H. PICKERING

THE GREAT NEBULA IN ANDROMEDA

FEW objects in the heavens have been treated with such unmerited neglect as this which has not inaptly been termed the Queen of the Nebulæ. Notwithstanding its enormous magnitude, spreading out, as followed by the Harvard 15-inch achromatic, to $2\frac{1}{2}°$ in length, (according to Bond—Trouvelot gives more), with a breadth of upwards of 1°; and its conspicuous brightness, readily perceptible with the naked eye, it has received little com-

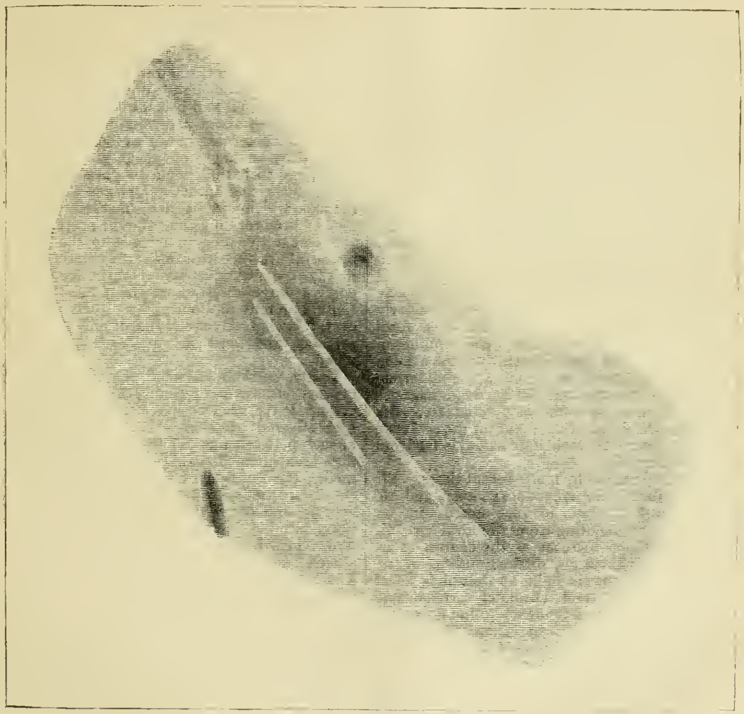

FIG. 1.—Bond, 1847.

parative notice. The reason probably may be the pertinacity with which it has hitherto resisted all inquiry, and defied the efforts of the most powerfully armed investigation; so that it seems to have been left on one side, as too unpromising for more than casual inspection. This however bears the character of a premature conclusion. Direct examination by the most powerful telescopes has done very little to solve the mystery of its nature. The reply extorted by the spectroscope is but partially intelligible. But we must not therefore despond

The negative or ambiguous results hitherto obtained do not preclude—on the other hand they rather invite—attempts of a different kind. If again defeated, we are only where we were before. If in any measure successful, we may indeed find the mystery only increased by partial solution; but such, after all, is the progress and the limit of all earthly knowledge. An obvious line of inquiry presents itself in the present instance, which seems not to have been adverted to in modern times—the possible evidence of variation either in form or brightness; and the following notices, neither as exhaustive nor as minute as the subject would otherwise admit, have been chiefly put together with this view.

The history of this nebula, which includes the ancient evidence, such as it is, of variation, is in brief as follows.

The first mention of it, according to the late Prof. G. P. Bond, the eminent observer at Harvard College, Cambridge, U.S. America, to whose memoir we shall be indebted for a considerable portion of our materials, occurs in an ancient star-catalogue with charts, supposed to date back as far as the close of the tenth century,[1] where it is represented of an oval form. Its previous omission in ancient catalogues is more easily accounted for than the remarkable silence of Tycho Brahe and Bayer. Marius (Mayer) in 1612 was the first to apply to it the recently invented telescope; his description of whitish rays, brightening to a dull and pallid centre, like a candle shining through horn, agrees sufficiently with its present aspect in a similar instrument. It again attracted notice in 1664, in consequence of the vicinity of a comet, for one of which bodies it has been several times mistaken, and it has never since been lost sight of, though Bouillaud thought its brightness variable between 1664 and 1666. In 1676 Kirch was of a similar opinion. Cassini in 1740 described it somewhat unaccountably as nearly triangular. Mairan in 1754 endorsed the description of Marius. Le Gentil in 1749 observed it circular and of uniform density; but oval, with central condensation, in 1757-58; and, from a consideration of all the known observations, believed it variable, without, however, being insensible to the differences arising from the inequality of optical means. Messier, on the other hand, whose familiarity with cometary phenomena rendered him a peculiarly competent witness, perceived no variation in a form similar to the present during the fifteen years ending in 1771; and since that time none appears to have been suggested. In fact when we bear in mind the imperfection of the ancient telescopes, and the known differences of vision and of judgment, by no means confined to earlier periods, we shall probably be of opinion that the evidence of change, though not to be rashly set aside, is far from amounting to demonstration.

We must however pass on to more recent times. Sir W. Herschel described it in 1785 as $1\frac{1}{2}^{\circ}$ long, and 16′ broad where narrowest; his son in 1826 noted that its brightness, gradually augmenting from the oval circumference, receives a sudden increase at the centre, so as to form a nucleus, but without any distinct outline, of 10″ or 12″ in diameter. The whole light he describes as of the most perfectly milky and absolutely irresolvable character, without the slightest tendency to the flocculent appearance of the Great Nebula in Orion. Ten years afterwards Lamont, with the Munich refractor of 11·2 (? English) inches, and a power of 1200, found the nucleus, of about 7″, longish in form, composed of very minute granulations, but without resolution.

Thus matters stood till July, 1847, when, soon after its erection, the great Merz achromatic of Harvard College was brought to bear upon it, with the confirmation of the almost star-like nucleus, but, owing no doubt to the unfavourable background of the summer sky, it was not till September 14 that the two dark rifts or canals were detected, which form so strange and peculiar a feature in this grand object. But no resolution was attained. It was estimated that owing to the light and sharpness of this admirable instrument upwards of 1500 stars were visible within the limits of the nebulosity, without the least apparent connection with it. And on which side they may lie who will presume to say?

We may now give a reduction from the drawing of Prof. G. P. Bond, adequate to our present purpose, though, from the difference of material, far inferior in delicacy to the original steel engraving. Great pains were taken in delineation, and numerous measures were obtained from the divided circles of the instrument; but an important admission of his must be borne in mind as to possible error in the comparative brightness of the different regions.

The drawing includes, it will be observed, two bright patches, one on either side of the grand central mass, but each involved in its diffusion, and therefore presumably, though not demonstrably, a part of the same complex structure. The more distant one below to the left, or north-preceding (for our diagrams give the inverted or telescopic view), was discovered by Caroline Herschel in 1783, and is known as H V 18, or No. 105 in the General Catalogue of Nebulæ. The other attendant, pointed out by Le Gentil, No. 32 in Messier's, 117 in the General Catalogue, is much smaller, but brighter, and of a circular form. The interior canal is the longer and more distinct, $1\frac{1}{2}'$ broad, very uniform for about half a degree, with straight, sharp, and slightly diverging sides; further north it begins to bend, and becomes fainter and less regular. The second is about 4′ distant from it, shorter, and less distinct, as occurring in fainter light. The two rifts are inclined at an angle of about 3°, opening towards the north, and their sides seem to have a common point of divergence; and in several places along the course of the axis, which was distinctly marked, there were gatherings of brighter knots and darker openings.

We next give a copy, reduced to the same scale, of a beautiful drawing with the same telescope by Trouvelot, in 1874; omitting, as unimportant for our present purpose, a large diffusion of faint nebulosity beyond the south extremity of Bond's figure. Of this drawing, however, it is expressly noted that it only gives a good general idea, and must be considered not as a map, but a picture.

Lastly, we shall add a sketch obligingly made for the express purpose of this paper by the Rev. Jevon J. Muschamp Perry, on December 14, 1881, with his great $18\frac{1}{4}$-inch silvered glass reflector by Calver, an instrument of such perfection as to admit of not only separation, but measurement of that excessively difficult pair γ^2 Andromedæ, the position of which Mr. Perry found, on December 10, 1881, by two measurements with a power of 600, 95° and 96°, with a distance of 0″·3.[1] It must be borne in mind that this is not, like Bond's and probably Trouvelot's drawings, a combination of results, but a single sketch; according, however, precisely with one taken on a previous night, and it is no less material to add that subsequent examination in clearer air revealed, as might be expected from the light-grasp of such an instrument, a much greater extension of nebulosity in every direction, equal, as it would seem, to that shown in the American observations.

In these two views taken with the same instrument after an interval of twenty-seven years, and a third six years later with a telescope of fairly equivalent power, we have before us the materials of an interesting comparison. The general similarity is obvious; but there are variations which it may not be well to ignore. One is, the form of the principal mass of light, spindle-shaped in

[1] The Persian astronomer Sûfi, Flammarion informs us, referred to it about the same period as a well-known object.

[1] The agreement is remarkable, in so close an object, with one of the Washington measures, 1880·039, 95°·8, 0″·35; their average for three years being 101°, 0″·358.

the earlier, globular in the two later drawings. This difference, while reminding us of the ancient variations of Le Gentil, may possibly not imply much, where no distinct outline is presented to rectify the judgment of the eye. But we have something more tangible in the length and form of the canals. Here, assuming equal care on the part of Trouvelot in designing, with that claimed by Bond both in delineation and description, we seem to have indications of change. It is true that Bond's account of the outer or shorter canal, as commencing a few minutes *np* the other, does not altogether agree with his drawing; but this is not the sole instance of confused "orientation" in his memoir; and at any rate he describes its commencement as only 4′ of space distant from the other. Trouvelot, as will be seen, has extended it much further *sp*; and should it be objected that this slenderer termination may have escaped the eye of Bond, it is curious to find it strongly and independently confirmed by Perry in two sketches on different nights, and by his express statement that "the *p* rift extends further than the *f* rift on the southern side." The greater breadth which he has given in each sketch to both canals is also worthy of notice. Another point of disagreement between Bond and Trouvelot occurs in the form of the longer canal: the "perfectly straight, suddenly terminated, and slightly diverging" sides, as far as the nucleus, of Bond's description, confirmatory of his drawing, according ill with the sinuous direction which Trouvelot has shown.

This may suffice for the collation of the results obtained by great instruments. But a comparison yet remains with the appearance in smaller telescopes; and it will be found deserving of attention. Let our aperture be restricted to 5 inches achromatic, or an equivalent light in a reflector: then, with ordinary vision and customary skies, the three salient points, the great centre, Le Gentil's ball, and Caroline Herschel's cloud, though much dimmed and contracted, keep their places, but all the attendant nebulosity will be swept away. Such at least is my own experience. On October 5, 1863, a few hours before the strong earthquake-shock, that will long be remembered in this part of England, I caught a portion of the inner canal with a $5\frac{1}{2}$ inch achromatic, and on August 24, 1864, I saw them both feebly, but certainly, with 8 inches of silvered glass, and have several times followed them with that mirror, and with my present $9\frac{1}{3}$ inch aperture, for a considerable length: but though traced, I cannot say that they would have been discovered. And latterly, whether from decay of visual power, or want of purer air, I have failed to detect them. But the general result is unmistakable. Either Bond's drawing must have exaggerated —and that materially—the light which they traverse; or that light must have since faded. The latter it must be owned is not probable. Yet his figure is fairly supported by his words, where he gives both canals near the nucleus as "beautifully distinct," and the light between them $\frac{3}{8}$ as bright as on the inner side of the longer one, and his design makes both rifts cleave, not as now, the feeble diffusion, but the great mass, not far from its very heart. On the other hand it must be admitted that probably at a not much later date, Lord Rosse's 3-foot speculum showed a much greater contrast between the opposite sides of that canal; and Trouvelot comes much nearer to the present aspect of things: so that nothing very satisfactory can be deduced here. The case however may seem stronger with regard to Caroline Herschel's nebula. There are discrepancies in the earlier values of its light. Her brother called it "pretty faint" with an area of 30′ × 12′, proving that he included with it much of the great nebula. His son, reducing it to 15′ × 7′, found it "pretty bright," though it stands as "very bright" in the General Catalogue. Bond shows it of a brilliancy superior to all but the light near the great nucleus and the centre of Le Gentil's ball. The Earl of Rosse, with the 6-foot mirror in 1876 complains of this delineation as "far too bright and sharply defined." Trouvelot again with a softer general effect has a small centre as bright as Bond; and this may perhaps be the nucleus faintly suspected by Sir John Herschel, and described by Lord Rosse in 1855 as bright and sharp: while the cautious and accurate d'Arrest (1861—67) using an 11-inch object-glass, and giving its size 12′ × $2\frac{1}{2}$′, speaks of it as only moderately bright, much more so towards the centre, but without a genuine nucleus. These details, needless and tedious as they may possibly at first appear, are introduced chiefly from their bearing on our present inquiry as to the probability of change, but in some measure as illustrative of the uncertainty that hangs about such observations. Every one may not be aware of the breadth of margin required, where there is no distinct outline, and faint diffusions fade out of all but the purest skies, and dilate and shrink by turns under the anxious gaze, and estimates of brightness are precarious, and artistic talent is often dissociated from the observer's skill. But after all allowances there can be no doubt that the existing aspect of this (Miss Herschel's) nebula with moderate telescopes is much less reconcilable with the designs of Bond and Trouvelot than might have been expected.

We can neither at present push this line of inquiry further, nor say that it has been very successful. Had it yielded us distinct evidence of change either in form or brightness, it must of course have been accepted as decisive against a stellar constitution; but we have only met with such probabilities as invite close and long research; and it was with a view of stimulating such research that the present paper was undertaken. A few more remarks may be permitted to render it less incomplete.

We stated originally that no resolution has ever been effected. This seems undoubted as to the grand mass.[1] The Earl of Rosse had indeed thought such development approaching with the 3-foot mirror, but only from an aspect presented also by the Dumb-bell and Ring nebulæ, since known to be gaseous; and the 6-foot giant broke down in its turn: and Newcomb has remarked that "in the most powerful telescopes the light fades away so softly and gradually that no such thing as resolution into stars seems possible. Indeed, it looks less resolvable and more like a gas in the largest telescopes than in those of moderate size." But there is less unanimity as to the two companions. Bond expressly states that under high powers 105 appeared to be a coarse cluster of stars. The 6-foot at Parsonstown on the contrary effected no such result; and we may remember that Bond had imagined momentary resolution in the Orion nebula. As to the bright ball, the Herschels and Bond lay no claim to success; the latter only remarking that the field preceding it contained multitudes of very small stars on a very even milky nebulous ground. Lord Rosse's 3-foot gave it resolvable; the 6-foot was silent.

D'Arrest once says, "nucleus stellatus circa medium"; at other times finds a nucleus equalling a 9 or 10 mag. star.[2] It has been thought resolvable by Buffham, and I believe by Key, and has certainly that aspect in my $9\frac{1}{3}$-inch speculum. But even were these two companions found to be of a starry nature, their connection with the principal mass (though in the case of 105 supposed by Bond to be indicated by a line of stars) would yet remain to be demonstrated. It may be improbable, but it is not impossible, that each may be a case of mere optical juxtaposition.

The telescope has comparatively failed. But the spectroscope remains—an instrument as superior in analytical as it is inferior in optical power. And here we get

[1] It is very remarkable that the usually accurate Humboldt should have so misapprehended Bond's meaning as to consider the 1500 stars scattered over the nebulous area as a proof of the resolution which he expressly disclaims.

[2] A similar appearance is so often ascribed in these beautiful observations to the centres of nebulæ, as to induce a suspicion of peculiarity, either of vision or of structure; in the latter case worthy of future attention.

some kind of reply; but still, except in one respect, an indecisive one. It precludes at once the idea of a simple gaseous condition such as that of the Ring Nebula, or the Dumb-bell, or the wonder in Orion: d'Arrest complains indeed of the feebleness of the principal spectrum; but all the three are continuous, as from stars. And yet they are peculiar, being deficient at the red end; at least this is expressly stated as to the central mass and the little ball. This peculiarity reappears elsewhere, not only among others in the beautiful nebulæ M 81 and 82, in Ursa Major, which are as yet unresolved, but in the great Hercules cluster M 13, and surely indicates some difference from ordinary stellar light. And again, as a fresh point of resemblance in general unlikeness, M 13, as well as our two nebulæ in Andromeda, is said by Huggins to have its continuous spectrum crossed either by lines of absorption or bright lines. So strange did this appear to that great observer that he was inclined to think in 1866 that perhaps the bright points in some clusters might not be of the same nature with true stars. At any rate the mystery, so far from being solved, seems only to be removed to a more inaccessible distance. What is that at which we gaze, overspreading field after field of the telescope with soft yet often vivid light? If gaseous, gas unknown, or in some hitherto unknown condition, or as Newcomb remarks, under an

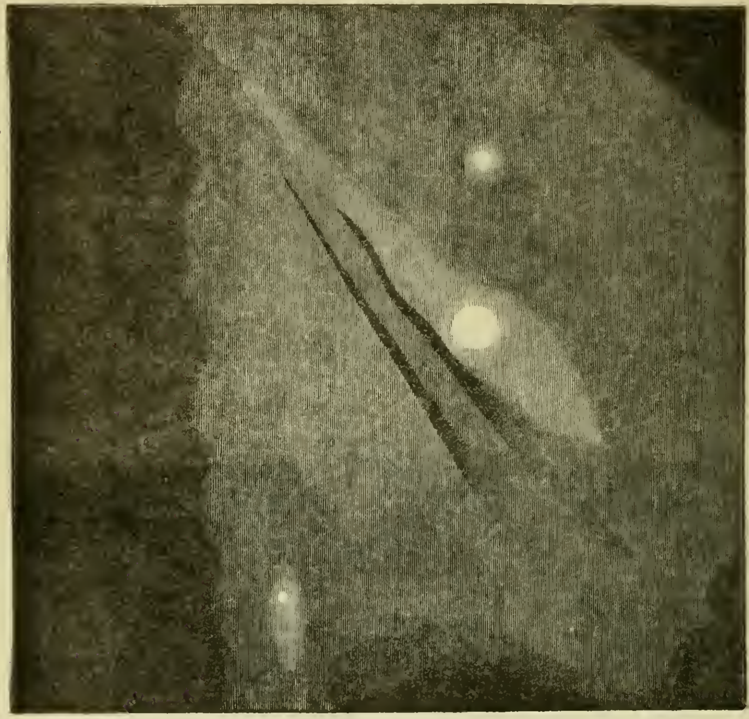

FIG. 2.—Trouvelot, 1874.

unintelligible amount of pressure. If stellar, how are its components so concealed, that neither in its extreme brightness, surpassing much, as I have especially noted, the great Orion nebula, nor in the evanescent faintness of its wide diffusion can they be insulated? If stars are there they must be numbered by hundreds of thousands; yet possibly of much lesser magnitude than we, from ancient habit, are apt unconsciously to associate with the idea of a star. The examination at least of many globular clusters has swept away old notions of size as well as distance; and there is no reason why bodies should not exist, not larger than the planets of our system, but emitting unborrowed light. And if such speculations may seem improbable, we may bear in mind that in venturing into these abysses we have intruded into a strange and mysterious region, where probability is left behind, and we have to deal with possibilities alone.

What again are those rifts, which seemed so strange to Sir John Herschel that he suggested the idea of the interposition of some less transparent material? Openings, perhaps, and indicating thinness of substance in the line of vision; openings which our earth, with its orbital velocity of 66,000 miles an hour, might possibly take years, possibly centuries, in crossing merely from side to side. This, however, must be observed, that they are not unparalleled in other nebulæ.[1] But what, in any case,

[1] Gen. Cat. 3106 (Com. Ber.); 3132 (Virgo); 3501 (Cape Obs.); perhaps

could be their origin? And how far are they shown to be unalterable?

And, in the last place, what is the distance or real magnitude of that luminous mass? Is it on this or the other side of the stars so profusely scattered throughout the same visible area? It may be nearer, or, more correctly speaking, less unimaginably distant, than we are apt to suppose. It might even show sensible parallax, if

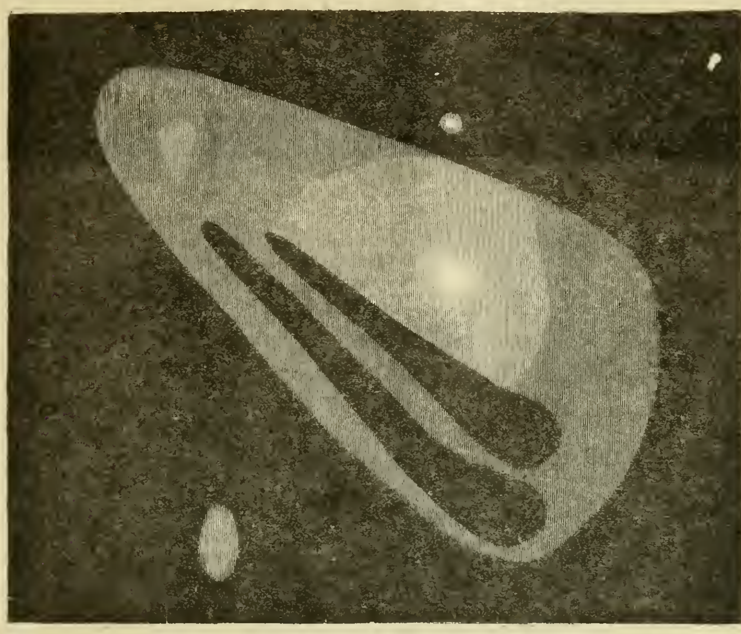

FIG. 3.—Perry, 1881.

d'Arrest's stellar point in 117 could be compared in position with neighbouring stars; and even so, an enormous extent must still be assigned to it. Or it may lie yet further away in the unfathomable depths of space, expanded to a gigantic size—the largest body in the visible universe—the greatest display as to magnitude of its incomprehensible Creator.

And with these inquiries as to a mystery never in all probability to be penetrated by man, our imperfect remarks shall close.

T. W. WEBB

4628 (Aquar. Gaseous). The first of these I have seen well with my 9⅓-inch speculum.

A BEAR FESTIVAL AMONG THE AINOS

ALTHOUGH it is well known that the Ainos of Yeso worship the bear, and have a festival known as the "bear-festival," at which that animal is killed, no foreign writer, except the one whom we are about to mention, has ever actually beheld this ceremony. Dr. Scheube, of Kioto, in a paper recently published in the *Mittheilungen der deutschen Gesellschaft für Natur und Völker-kunde Ostasiens*, describes one at which he was an honoured guest. He observes that these celebrations are becoming rarer every day; in the various villages which he visited there had not been one for some years. The motives assigned for this cessation of an old custom, is that the Ainos are becoming *Japanised*, and that the expenses are too great. In those parts of the island where Japanese habits have penetrated most, the absence of the skulls of the bears, which are also objects of veneration, is very noticeable; and as the individual who gives a bear-feast is compelled to invite all his relations, friends, and neighbours, and to supply them with unlimited quantities of *saké* (rice-beer)—a beverage which is three times more expensive in Yeso than in Japan—the excuse on the score of expense is probably a valid one. It is, it seems, incorrect to say that the Ainos reverence the bear as they do their gods—the god of the fire or of the sea, for instance; but they respect the bear above all other animals. He is most useful to them; he supplies them with food, raiment, and even with medicine. On the other hand, when enraged, the bear is a terror to them; he destroys their houses, plantations, and domestic animals, and kills themselves. The animal intended for sacrifice is selected while it is still very young, towards the end of winter, it is nourished by the wife of its owner at first, and when it gets stronger is fed on fish alone. In the beginning it runs freely about the house, but as it increases in size and strength it is placed in a cage. About September or October, when it is a

year old, and has become so strong that it attempts to break its cage, the time for the ceremony is deemed to have come, and the great event of an Aino's life is about to take place. He first addresses long prayers to the gods and to the relations of the bear asking pardon for what he is about to do, and pleading that from the time the animal came into his possession he has showered favours on him, and has maintained him as long as possible; but he is poor, the bear is growing large, and he finds it impossible to support him any longer. He has therefore no resource but to slay him; and for this act, which is forced on him by inevitable necessity, he prays for forgiveness.

On arriving at the scene of the ceremony the visitor found about thirty persons, chiefly residents of the place, assembled, and dressed in their gala costumes, which consisted chiefly of old Japanese brocaded garments. From the commencement to the end *saké* played almost as prominent a part as the bear himself. The guests sat around the fire-place in the centre of the host's hut, and an offering was first made to the god of fire. This was done in this wise. The Ainos, who were all seated, raised their left hands, holding a drinking vessel, to their foreheads, while the palm of the right was also elevated slightly. A small stick lying across the cup was then dipped in the *saké* and the contents sprinkled on the floor to the fire-god, the stick being then waved three or four times over the cup. A formula was uttered by each person present, and the *saké* drank in long draughts, the stick being meanwhile employed in holding up the moustache. A similar ceremony then took place in front of the bear's cage. This was followed by a dance around the cage by the women and girls. Offerings of drink were then made as before to other gods, and finally the bear was taken out of his cage by three young men specially selected for the purpose. The animal was killed by pressing the throat firmly against a large block of wood. The body was then cleaned, and placed neatly on a mat, food and drink being laid before it, and ornaments of various kinds being placed on its ears, mouth, &c. Mats were spread around the bear, the guests took their seats on them, and the drinking commenced. This continued for some time, until the Ainos sank in a state of helpless intoxication on their mats. The women in another part of the village meantime amused themselves with various dances, which Dr. Scheube describes at length.

The following day, as a rule, the debauch is continued. The body of the bear is then cut up in such a manner that the hide remains attached to the head. The blood was collected in vessels and drank by the men. The liver was cut out and eaten raw; the rest of the flesh was distributed amongst the partakers of the feast. The writer states that although hardened in a certain sense to the sight of blood, he could not look without horror on the sight of the drunken crowd with their faces and bodies smeared with blood. The skull of the bear—stuffed with charms—is placed in a sacred place on the east side of the house, and the mouth is filled with bamboo-leaves. It is then always preserved and venerated as a sacred object.

NOTES

MR. WILLIAM BOWMAN, LL.D., F.R.S., has been elected Honorary Secretary of the Royal Institution, and Dr. Warren De La Rue, F.R.S., Manager.

ON Monday the Royal Commissioners on Technical Education—Mr. B. Samuelson, M.P., Mr. Woodall, M.P., Prof. Roscoe, Mr. P. Magnus, Mr. Swire Smith, and Mr. Redgrave, secretary—visited Liverpool to inquire into technical science teaching. They met at the Free Library, and were furnished with information concerning its working by Sir James Picton. They afterwards visited several of the Board schools, and in the evening some of the science classes.

DR. P. L. SCLATER, the Secretary of the Zoological Society, will give the first of a course of four lectures on the Geographical Distribution of Animals, on Thursday next, February 16, and Mr. W. Watkiss Lloyd the first of a course of four lectures on the Iliad and the Odyssey, on Saturday, February 18, at the Royal Institution.

AT the comparatively early age of fifty-two years Major Sir William Palliser, C.B., M.P., died very suddenly from heart disease on Saturday afternoon. Sir William Palliser was universally known through the projectiles that bear his name, and for many practical applications of science in both offensive and defensive armament.

KÖNIG'S great tonometer is, we observe, announced for sale. It would be a great pity if the opportunity of acquiring this magnificent and absolutely unique collection of standard tuning-forks for the nation were thrown away. The collection was one of the finest things exhibited in Philadelphia, where it still lies, the project to purchase it for the University of Pennsylvania having fallen through. If it cannot be acquired for the national collection, of which a nucleus exists at South Kensington, surely it might be thought worth while to purchase it for either the Cavendish or the Clarendon Laboratory. But the nation that can give two thousand pounds for the plaster cast of the porch of a Spanish church can surely afford to buy the masterpiece of the master-maker of modern acoustical instruments, especially at the moderate price asked.

UPON the Island of Euboea fossil human remains are reported to have been recently discovered. The Greek Government has had the objects in question conveyed to Athens, where their scientific examination is now ordered.

THE February number of the *Deutsche Rundschau* will contain an article by Prof. Häckel, of Jena, the celebrated evolutionist, on his scientific researches in India, where he has been travelling since last autumn and still is.

IMPORTANT steps have been taken towards the execution of the French Metropolitan Railway, the principal technical difficulty being the crossing of the Seine. The first line to be constructed will originate from St. Cloud, and have its terminus at Vincennes. Its underground run will begin at the rue de Rome; other stations will be at the Opera, Bourse, Arts-et-Métiers, Place de la République, and Place de la Bastille. The track from the Place de la République to the Place de la Bastille is not yet decided upon, owing to the difficulty of crossing the Canal St. Martin's. The work will commence with the opening of a new street in the most densely-crowded part of Central Paris.

A "GEOGRAPHISCHE GESELLSCHAFT" was founded last month in the University town of Jena, under the presidency of Dr. Schmid, one of the professors. Their *Mittheilungen* is to be a quarterly one, and is to chronicle the geographical and ethnological researches of missionaries. The first part is to appear towards the end of March. These societies are springing up all over France so fast that their very names slip one's memory, but in this country we are still content with one, no more having been heard of the feeble attempt made to start a Commercial Geographical Society at Manchester.

FROM the *Colonies and India* we learn that valuable and important discoveries of copper and iron ore have been made at

Tamworth in New South Wales, and that at Tamora the diamond drill has discovered water at a depth of 400 feet, the site of the boring being on a rocky hill 100 feet above the alluvial flat, on which the town is situated.

The French Government has instituted a commission of inquiry into the actual position of working-men engaged in the industrial arts. The commission, composed of members of both houses of the French Parliament, engineers of the public service, and leading manufacturers, has held already two sittings in the Conservatoire des Arts et Métiers, where a special room has been fitted up for examining witnesses. The depositions are taken by shorthand writers, and will be published at full length, to support the recommendation of the committee.

We are informed that the great Danish work entitled "Icones Floræ Danicæ," whose completion has been long anxiously desired by botanists, will be ready for publication in the course of 1883. The work, of which the 51st number has appeared, will in its entirety consist of fifty-four numbers, three of these being supplementary parts devoted to the consideration of Swedish and Norwegian plants not included in the flora of Denmark. Subscribers, or intending purchasers, should apply without delay for the copies they require to Prof. Joh. Lange, or to Messrs. Lehman and Stage, Copenhagen, as it is proposed to break up the plates as soon as the last number has been struck off. An exception will, however, be made in regard to a few of the plates, in view of the possibility of their being used in the production of three other works, which the publishers and editors of the "Icones Floræ Danicæ" propose to issue, provided a sufficient number of subscribers can be secured. These works are: (1) "Icones Floræ Grœnlandicæ," with letterpress and 330 plates; (2) "Arboretum Scandinavicum," including the indigenous trees of Denmark, with 160 plates; (3) Icones Plantarum Officinalium Scandinaviæ," with 300 plates.

M. Paul Bert, before the resignation of the Gambetta Ministry, had instructed M. Dumas, the Permanent Secretary of the French Academie des Sciences, to draw up a list of scientific men who have died or received injuries while making experiments or researches for the advancement of science. Pensions, it was proposed, should be given to the widows and families of those who had fallen victims to their scientific ardour, whilst those whose injuries have not been fatal will receive substantial aid. We trust the change of Ministry will not affect this laudable proposal.

M. Plateau lately sought to estimate the distance to which the moon is mentally referred in the sky, by getting some one, after looking at that body, to project the accidental image on a wall, then move to or from the wall till the diameter of the image seemed equal to that of the moon; and he obtained the distance 51 metres. Again, Prof. Thirion, of Namur, got twelve students to draw on a black board a circle the size of the moon as it appeared to them. The circles varied from 19 to 79 ctm., mean 32 ctm., and it was inferred that the moon was mentally referred, on the average, to about 35 metres. Dr. Charpentier, by still another method, obtains the value 12·9 metres, so that there are great differences, and in any case the distance is much less than might have been thought. M. Plateau has further applied accidental images to finding the distance to which the imaginary celestial vault is referred. A spot in a white square of paper on a dark ground was looked at steadily at the side of an open window for twenty seconds, then the person looked skywards, above the opposite houses, then to one of these houses, and compared the sizes of the accidental images in either case. The sides of the two were by one person estimated as 5 to 6, by another as 4 to 5; and the width of street being about 30 metres, the distance assigned to the celestial vault is inferred to be in one case 30, in the other 29 metres. A similar result was got by night.

Most encouraging to any, who have hitherto worked unsuccessfully towards establishing a Free Library, should be the picture of past and present which is given in the First Annual Report of that institution at Newcastle-upon-Tyne. The failure of the first effort in 1854, the cold feeling indicated by the very small number of votes against and for the adoption of the Free Libraries Act in 1872, the further delay till 1878 and 1880, contrast strangely with the handsome new building; the large proportion of borrowers to the population, the appetite for reading among these borrowers causing the large circulation, and the 23,000 well-selected and well-catalogued books (see Nature, vol. xxiii. p. 262) which this report can boast of. The wisdom of the Newcastle committee in devoting money as well a labour to the purpose of thoroughly well doing this work of cataloguing is confirmed by the sale of 6000 such catalogues at 1*s.* each. The importance of the Juvenile Library comes out strongly also, nearly half the borrowers (4413) being under twenty-one years of age, and the turn-over of books being by far the greatest in that department. An immense work is being done by this means, and there must be room for much more power, being devoted profitably to the production of these influential works. This library is fortunate in its large spaces for stowing away Blue Books, Transactions, and newspapers, which no public library should be without, yet which fill up so much space; in its arrangements for home binding; it is fortunate in the fact that its 1*d.* rate brings in over 2800*l.* a year, and we hope that under the new Act to be brought in next Session, it will be fortunate in getting more.

In a recent number of *Naturen*, Hr. Bergh has drawn attention to the powerful agency exerted by ice in severing rocks, of which he gives a striking instance occurring on the Aalesund in West Norway, where a low ledge rising out of the fjord is all that remains of a once extensive fjæld promontory, which in the year 1717 was suddenly blown up and precipitated into the water by the force of the ice within the interstices of the stone. The winter had been mild, and during a rapid thaw a considerable stream had welled up from the ice-covered summit of the fjæld, and carried its waters into every crevice of the rock, when a sudden change of wind brought about a sharp frost, which turned the descending waters of the newly-formed stream into ice, arresting their course within the interstices of the rock. The result was the explosion of the entire mass of the fjæld below the outbreak of the stream, and its projection from a height of more than 1500 feet into the neighbouring fjord, which engulfed the whole of the promontory, with its cultivated fields and farmstead. Simultaneously with the disappearance of the land below the surface of the fjord, a huge mass of waters was propelled against the opposite shore, carrying with it rusty anchors, boat-rafters, and numerous other objects which had long lain at the bottom. The disturbance extended a mile beyond the point at which the land was submerged, and the waters in retreating carried with them a wooden church which had stood fifty feet above the fjord, besides sweeping away all the fishing-boats for a distance of two and a half miles. Before this occurrence, which was attended by loss of life to about a score of persons, the headland had been much resorted to on account of the halibut, which abounded in the neighbourhood, but since that period the fish has never returned, a circumstance which, according to local popular belief, is due to the covering up by the infallen rock of certain submarine cavities and springs frequented by the fish.

A most interesting experiment has taken place at the Comptoir d'Escompte of Paris, one of the leading bank-

ing establishments, in its new building, rue Bergere 16. Not less than eighty electric regulators, and a large number of Swan lamps, have been illuminated by Grenet's battery. The illumination will continue every night after a very few days, when the new offices will be occupied by the staff of the Company. One of the peculiarities of this system is that the offices are illuminated by the Jaspar reflecting system, but it is the ceiling itself which is used as a reflector. The effect is splendid. The large hall is illuminated from the top by sixteen Serrin and Siemens' regulators. The arc is concealed by a ceiling of coloured lights. Swan lamps are used for the staircases, and the chambers where the valuables are kept. All the offices are connected with the head office by telephones, pneumatic tubes, and telegraphs. The battery is controlled by electrical agency. The fifty elements are placed in the upper part of the edifice as well as the tanks for keeping the liquid. When it is used it is collected in another tank placed in the lower part, from which it is carried by special carriages and brought to a special workshop at some distance. In this workshop the zinc is regenerated, as well as the sulphuric acid and the sesquioxide of chromium is changed again into chromate. The cycle of regeneration is complete, and we may give details as to its working. The suppression of reflectors and the use of the ceiling in their stead was devised by M. Corrayer, the architect of the Comptoir d'Escompte.

THE water of Lake Maggiore, which it has been proposed to convey to Milan, has lately been examined by Prof. Maggi by M. Certe's method, the samples being taken at 65 metres depth, and about 400 m. from the banks. Forty-eight hours after a little osmic acid was added, there was obtained a small deposit of dead organisms of bacterian form, none of which had appeared in the microscope. He found a solution of chloride of palladium to have also the effect of hardening those small organisms and so making them opaque and microscopically visible. Small irregular masses of protoplasmic nature, capable of taking colour from a magenta solution, were also thrown down. Prof. Maggi further treated the water of the lake with various colouring agents. Hematoxiline, methyl-violet, magenta, and Lione blue gave the best results. While the same small organisms and protoplasmic masses were manifested, only the latter, curiously, took colour. In spring water of Valcuvia, and rain water, microbes like those in the lake, not visible in a microscope of 800 diameters, were revealed by the colouring and hardening reagents. Prof. Maggi proposes to call these organisms *Aphaneri*, as distinguished from the bacteria and microbes, which, without reagents, are visible in the microscope (*Phaneri*), and among which are agents of infection, and which take colour from methyl-violet, magenta, &c. The Aphaneri, he thinks, are probably harmless.

Among the new subjects for prize competition announced by the *Reale Istituto Lombardo* we note the following: Illustrate with new facts of pathological anatomy and experimental physiology the doctrine of cortical sensory centres (for 31 May, 1884, prize 2000 lire); Monography of magneto electric and dynamo-electric machines, comprising the history and theory, and indicating the merits and defects of the different types with regard to their various industrial applications (for 31 December, 1883, prize 4000 lire); History of the life and works of Leonardo da Vinci (for 31 March 1886, prize 5000 lire); Geognostic, chemical, and physical study of the agrarian soil of a portion of Lombardy (for 31 May, 1883, prize 1500 lire and gold medal 500 lire). Further particulars will be found in the *Rendiconti* of the Institute

THE Birmingham Town Hall was crammed from ceiling to floor on Sunday night to hear a lecture on Natural History delivered by the Rev. W. Tuckwell, at the invitation of the Sunday Lecture Society. The subject was a "Day on the Hills," and the delight of the rough audience was unbounded at the wonders from bog and hill-top, pond and stone-quarry, revealed to them by the lecturer, who, without "preaching," gave more than once a religious turn to the discourse. Hymns were sung and sacred music performed before and after the lecture. The local papers point out that of the 3000 and upwards present the great majority were persons who do not usually attend church or chapel.

WE learn that Dr. Andrew Clark has consented to preside at a lecture on the "Dress of the Period," to be given by Mr. Frederick Treves, of the London Hospital, on Saturday afternoon, February 26, at the Kensington Town Hall, at 4 o'clock. The lecture is given under the auspices of the National Health Society.

THE Lake of Constance is now lower than at any time since 1805. At Hoerulin, on the Swiss side, some interesting Lacustrine habitations have been laid bare, and several valuable finds of nephrite axes and other objects have been made.

BEFORE leaving, the Minister of Public Instruction, M. Paul Bert, signed a decree establishing the Popular Observatory, which we have mentioned already in our Notes. The report was drawn by a Commission composed of Admiral Mouchez, M. Flammarion, and others.

M. FLAMMARION will start, in the month of March, a monthly astronomical paper, to be published by Gauthier Villars. Each number will be profusely illustrated.

ON Monday last the cuckoo was heard in the policies surrounding Halleath, Lochwaben, Dumfriesshire, the weather on that day being remarkably bright and warm.

WE have on our table the following books:—Elementary Physiography, by Andrew Findlater (Chambers); Original Gravity, by J. A. Nettleton (Lampray); Market Garden Husbandry, by W. H. Ablett (Chapman and Hall); Sahara und Sudan, by G. Nachtigal (Paul Parey, Berlin); The Honey Ants and Occident Ants, by McCook; The Water Supply of England and Wales, by C. E. de Rance (Stanford); Mountain Life in Algeria, by Edgar Barclay (Kegan Paul and Co.); Between the Amazon and Andes, by Mrs. Mulhall (Stanford); Vignettes from Nature, by Grant Allen (Chatto and Windus); The Story of our Museum, by the Rev. H. Housman (Society for Promoting Christian Knowledge); Year-Book of Photography, 1882, by H. Baden Pritchard (Piper and Carter); Outlines of Physiography, by G. Thom (J. Thin); Sounds and their Relations, by A. M. Bell (Trübner); Philosophy of Self-Consciousness, by P. F. Fitzgerald (Trübner); Consumption, by De Lacy Evans (Baillière, Tyndall, and Co.); Report of the Lightning Rod Conference (Spon); Sparks from a Geologist's Hammer, by Alex. Winchell (Trübner); Lessons on Form, by R. P. Wright (Longman); Myth and Science, by Tito Vignoli (Kegan Paul and Co.); Practical Microscopy, by George E. Davis (David Bogue); Aristotle on the Parts of Animals, translated by W. Ogle, M.D. (Kegan Paul and Co.); Transit of Venus, 1874, by Sir G. B. Airy (Stationery Office); An Old Chapter of the Geological Record, by King and Rowney (Van Voorst); Dental Anatomy, by C. S. Tomes (Churchill); Tunis, Land and People, by Chevalier de Hes-e-Wartegg (Chatto and Windus).

WE are asked by the author to state that at the end of the third paragraph of the article on "The Recent Weather" in NATURE, vol. xxv. p. 285, the barometric pressures inadvertently quoted as 30·093, 30·079, and 30·076 inches, should obviously have been 30·930, 30·790, and 30·760 inches.

THE additions to the Zoological Society's Gardens during the past week include a Sykes's Monkey (*Cercopithecus albigularis* ♂) from East Africa, presented by Mr. H. Gunning; a Ring-tailed Lemur (*Lemur catta*) from Madagascar, presented by Capt. M.

P. Webster; two Badgers (*Meles taxus*) from Russia, presented by Mr. C. R. Meltzer; a Cinereous Sea Eagle (*Haliaetus albicilla*), European, presented by the Hon. M. Finch Hatton; two Common Barn Owls (*Strix flammea*), British, presented by Master Golden; a Mountain Ka-Ka (*Nestor notabilis*) from New Zealand, deposited; two Snow Buntings (*Plectrophanes nivalis*), two Mountain Linnets (*Linota flavirostris*), a Cirl Bunting (*Emberiza cirlus*), British, purchased.

OUR ASTRONOMICAL COLUMN

The Observatory of Melbourne.—The sixteenth annual report to the Board of Visitors of this Observatory has been issued by the Director Mr. Ellery. The staff now consists of the Government Astronomer, the Chief Assistant, Mr. White, and three junior assistants. Mr. White takes charge of the meridional work, and on Mr. Turner devolves the observation, drawing, and photography in connection with the great telescope, and obtaining daily sun-pictures with the photo-heliograph. The large telescope almost monopolises the services of a workman. The actual work with this instrument during the year ending June 30, 1881, to which the Report refers, was performed on sixty-eight nights, twenty-four of which were devoted to lunar photography, unfavourable weather, or bright moonlight is stated to have interfered on 125 nights, while eighty-two nights were occupied with the great influx of visitors to the Observatory, during the continuance of the Melbourne International Exhibition. Twenty-two nebulæ of Sir John Herschel's Catalogue were observed and sketched, with a new one, preceding No. 3705 by 1m. 7s., and 4′ 30″ south. The majority of the nebulæ observed agree well with Herschel's description, but Nos. 4502, 4510, and 5012 do not accord with his measures; 3430 is found to be much more suddenly condensed in the centre, and 3734 is much fainter than he describes. The nebula surrounding η Argûs was carefully compared on three occasions with drawings of 1875, but no decided change could be detected. During the year, 175 photographs of the sun were obtained showing a marked increase of spots and disturbances of the surface. The magnetical and meteorological work and progress of intercolonial meteorology are also subjects of the report. The Government had approved of the purchase of a new transit-circle more adequate to the requirements of the day than the existing instrument, and the necessary amount had been placed upon the estimates.

The Observatory of Cordoba.—Dr. B. A. Gould, writing on December 22, mentions that the first volume of the Cordoba astronomical observations was finished, and he expected to forward it to Europe during the ensuing week. A meteorological volume would follow immediately.

The Great Comet of 1881.—The following places depend upon the last ellipse calculated by MM. Dunér and Engström of Lund:—

At 12h. Berlin M.T.

	R.A. h. m. s.	Decl. ° ′
Feb. 11	0 10 15	+55 2·8
13	0 14 24	54 57·6
15	0 18 30	54 52·9
17	0 22 34	54 48·5
19	0 26 36	54 44·6
21	0 30 37	54 41·0
23	0 34 35	54 37·8
25	0 38 32	54 35·1
27	0 42 27	54 32·7
March 1	0 46 20	54 30·6

On the first date, the comet's distance from the earth will be 3·76, and on the last date 4·14, the earth's mean distance from the sun being taken as unity.

Problematical Sun-spots.—As a somewhat similar case to that recorded by Sir William Thomson in last week's Nature, we may recall an observation by Lichtenberg on November 19, 1762, described in a letter from his brother in Zach's *Allgemeine geographische Ephemeriden*, 1798, p. 260; the observation had been mentioned in Götting's *Taschenbuche* for 1787, p. 121. In Lichtenberg's diary he had entered the particulars as follows: On November 19, 1762, as, in company with a friend, v. Pöllnitz of Reinheim, he was journeying from Wurzburg towards Erlangen early in the morning, one of great cold and thick vapours, their attention was directed at sunrise, by the conductor of the vehicle, to something upon the sun's disk; he had not wholly risen in an unimpeded view, was of a blood-red colour, and, as usual, seemed magnified. Under these circumstances Lichtenberg says he saw with the naked eye, to his no small surprise, a dark, well-defined spot, the diameter of which he estimated at more than a twelfth of the apparent diameter of the sun: "etwas unter dem Mittelpunkte gegen den nördlichen Rand." It is added "Die vollkommen runde Gestalt und der völlig reine Ausschnitt liessen auch beim ersten Anblick schon etwas Anderes als ein gemeinen Sonnenfleck von seltener Grösse vermuthen. Er dauerte auch nicht lange, so sah ich deutlich, dass ich mich in meiner Meinung nicht geirrt hatte, denn der Körper hatte seine Stelle merklich verändert." The journey to Erlangen was hastened in the hope of arriving there before the egress of the spot, and on reaching the town Lichtenberg says he hurried to Prof. Arnold to secure confirmation of his observation, but although immediate steps with that object were taken, the body was found to have passed off the sun, which appeared round and spotless.

The brother who communicated these details to Zach, considered that in conjunction with a diagram, it followed that the object had described a chord of nearly 70° on the solar disk in about three hours; the direction being from the north limb towards the south.

GEOGRAPHICAL NOTES

The French African traveller, M. de Sanderval, has returned to Paris from his expedition to Timbo. His principal object was to find the route which European travellers have searched for for more than a century, and which is destined eventually to become the main route by which civilisation will progress from the coast to the Upper Niger and the Soudan. During his first journey in 1879 M. de Sanderval obtained permission to construct a railway from the Iman of Timbo and grant of a district of 12,000 square kilometres. The maps and notes of the traveller will be presented to the Academy by M. de Lesseps.

At the meeting of the Geographical Society on Monday last, Mr. Cuthbert E. Peek read a paper on the journey across Iceland which he made last summer in company with Mr. E. Delmar Morgan and Mr. J. Coles. Mr. Delmar Morgan afterwards gave an account of an excursion which he made by himself to Askja, the only Englishmen who have visited it before having been Messrs. Watts and Lock. The interest in Mr. Peek's expedition centres almost entirely in the fact that he had been entirely trained to the use of instruments, &c., at the Geographical Society under Mr. Coles, the instructor, and the result shows that the system adopted is useful and effective.

In the Geographical Society's *Proceedings* this month, the only papers are those read at the meeting of January 16, and alluded to in our issue of January 26. The map on which the routes of Mr. Thomson and the Rev. C. Maples are laid down, is a useful contribution to the geography of East Africa. A note on Mr. O'Neill's journey in the interior of Mozambiqne dissipates all hopes which may have been formed that he had visited the snow-clad mountains there. Mr. O'Neill appears to have reached a point within sight of the lofty peak Namuli, said by natives to be capped with snow, but owing to clouds he could not verify this statement. Much useful information will be found collected together under the head of Père Duparquet's journeys in Ovampo-land. The remainder of this issue is largely devoted to foreign societies, among the reports of which will be found authoritative accounts of Dr. Stecker's work in Abyssinia, and Mr. Poliakof's in the Island of Saghalien.

It is stated that Col. Prjevalsky intends shortly to start on another expedition to Tibet, and we hope that this time he may at length succeed in reaching Lhassa.

Col. Veniukof has furnished the French Geographical Society with some notes of Dr. Regel's new journey in Central Asia, principally in Karategin and Darwaz. His explorations commenced on the banks of the Macha, near the Zarafshan Glacier, whence he went first to Garm, the capital of Karategin, traversing the mountains by the Pakshif defile, and descending into the valley of the Kizil-su by the little river Sor-bokh. From Garm he went to Kela-Khumb, traversing on the way the valley of the River Wakish or Wakhia, and the Kamchirak, Sagridesht, and Khubu-rabat passes, the first of which is 9500 feet above the sea. Further on he followed the valley of the Oxus as far as the confluence of the Warij, which the natives

consider one of the two principal sources of the Amu-daria, the other being the Pianj. According to their statements the Ak-su, which waters the Pamir, is an affluent of the Wanj, and does not fall into the Pianj near Kala Wamar, the affluent of the Pianj being called the Chun-uk-daria, which flows out of the Yashil-kul. In order to assure himself of the truth of these statements Dr. Regel followed the Wanj as far as Tesb-i-Senghi, and be found that the river contained abundance of water. He intended to spend the winter at Darwaz, in order to resume his explorations in the spring, and it may be hoped that he will succeed in solving the last remaining mysteries of the Pamir.

MR. S. E. PEAL's account of his expedition in 1879 to the Nongyang Lake and to the pass over the Patkoi Range will be found, with map and panoramic sketches, in Part 2, No. 1, of the Bengal Asiatic Society's *Journal* for 1881.

THE following despatch has been received at the London office of the *New York Herald*:—"Irkutsk, February 1, 1882, 2.45 p.m. Our three boats left Semenofsky Island on the morning of September 12, bound for Barkin, ninety five miles distant. We got clear of ice at noon. Heavy gale from north-east, and boats dispersed during night; captain's boat, loaded deep, lost mast and sails. We made land on the evening of the 17th, shoal water. Boat abandoned two miles from beach; party waded and reached deserted village, Saga-tor; 'cached' log books; proceeded south on the 19th. Delong's last record found reads as follows:—'Saturday, October 1st.—Fourteen of the officers and men of the *Jeannette* reached this hut on Wednesday, September 28, and having been forced to wait for the river to freeze over, are proceeding to cross to the west side this morning on their journey to reach some settlement on the Lena River. We have only two days' provisions, but having been fortunate enough thus far to get game in our pressing needs we have no fears for the future. Our party all well, except Ericksen, whose toes have been amputated in consequence of frostbites. Other records will be found in several huts on the east side of the river, along which we have come from the north.—(Signed) GEORGE W. DELONG.' Three subsequent records had been found. Ericksen died October 7; party in great distress for food. Noros and Nindemann sent ahead for relief, October 9. They marched south fifteen days, and were found in a starving condition, October 24, by three natives, who took them to a settlement. They could not make themselves understood. News of them reached us October 29. Immediate search commenced, and party traced to a wilderness on left bank of Lena. Natives refused further work, and return to Bulong; was necessary to get Russian assistance.—November 28.—A large party is now searching, having to dig out everything deeply covered with snow. The wilderness devoid of game. Very prompt and efficient action by Russians. Every effort is being made. Jack Cole's tranquil to-day; violent only at times; softening of brain. My left eye ruined, and right one badly impaired. Other men well. Jackson has telegraphed me from Orenburg.—JOHN DANENHAUER." Semenofsky Island is probably a small island marked Semenov in the map in the "Voyage of the Vega," on the north-west of Stobovoi Island in the New Siberia group. Barkin is on the north-east point of the Lena delta, where there is a winter tent. Sagastyr, where they landed, is at the mouth of the most northern branch of the Lena delta. The engineer Melville has made arrangements for a thorough search for the missing party, at once.

THE PRIZES OF THE PARIS ACADEMY OF SCIENCES

THE annual distribution of prizes at the Academy of Sciences took place on Monday February 6. M. Wurtz, president for the year 1881, was in the chair. The list of laureates was read by M. Dumas.

The prize of 240*l*. for any improvement in the French naval forces was awarded to M. Sébert for his apparatus for measuring the velocity of projectiles, and to M. Brault for his study of naval meteorology.

The Lalande Prize was awarded to Prof. Swift of Rochester, (U.S.) for the discovery of seven comets in the brief interval of four years. Another astronomical prize was awarded to Mr. D. Gill, director of the Cape Observatory, for his determination of the solar parallax by observations of Mars.

The prize in Physics was awarded to M. Planté for his accumulators, and the Commission records the wonderful experiment which was executed by this physicist when he obtained a tension of 1200 elements with two Bunsens. Amongst the other prizes which may present some special interest are the following:—M. Briot, for his work, "Sur les Fonctions Abeliennes"; M. Etienne Gilbert, "Étude sur les Philtres, Charmes, Poisons." No prize was awarded for the question "to ascertain by direct observations and experiments the influence of exterior objects on the structure of vegetative organs," but a sum of 60*l*. was delivered to M. Mer to encourage him to work again at the same question which remains open for competition in 1882. One of the Monthyon Prizes was awarded to Dr. Favre for his work on Daltonism, and another to Dr. Paul Richer for a treatise on hystero-epilepsy. M. Collin took the interest of the Breant Prize for his work on "Epidemical Affections." This prize, originally destined for a remedy against cholera, amounts to 4000*l*., and the interest is distributed every year, to avoid indefinite accumulation. A posthumous prize was awarded to M. Henri St. Claire Deville for his discovery of the law of dissociation. The rules forbid the Academy to give such an honour to any of its living members, and it is the first time on record that it has been given to a departed one.

When the long series of laureates was recited, M. Bertrand, perpetual secretary for the section of Mathematical Sciences, read the *éloge* of Leon Foucault, the inventor of the gyroscope, electric light regulator, siderostat, silvered glass telescopes, determination of velocity of light, &c. M. Leon Foucault was born in Paris in 1819, he died in the same city in 1868, and never travelled abroad. He was self-educated, having passed his honours only when already illustrious. M. Bertrand has written the preface to the collection of his scientific works, published in 1878 by his mother—a large 4to volume of 600 pages. M. Leon Foucault was besides a very active and successful writer, having been the scientific editor of the Feuilleton of the *Debats* for years. His successor is now M. de Parville.

INSTITUTION OF MECHANICAL ENGINEERS

THE Annual General Meeting of this Institution was held at the Institution of Civil Engineers, Great George Street, on January 26 and 27.

The Annual Report of the Council drew attention to the subjects of experimental research, of which some account has already been given in NATURE. With regard to riveted joints, it appears that a long and elaborate series of experiments have been carried on for the Committee by Prof. Kennedy, at the Engineering Laboratory, University College. These experiments dealt exclusively with steel plates and rivets, and were directed first to ascertain the constants of resistance to tension, shearing, &c., in mild steel, the knowledge of which is necessary in order to design the strongest form of joint, and secondly to test joints designed on the basis of the values thus discovered, as against other joints, made purposely to have an excess or defect in one or other of the areas through which fracture might take place. The work has been completely successful; the correctly-designed joints giving decidedly the best results, and thus affording a satisfactory verification of the value determined for the constants. The experiments have further brought out strongly the fact that joints in iron and steel must be designed in a very different manner to give the best results in each, the reason being that the shearing resistance of the rivets is about the same in iron and steel, while the tensile resistance is much higher in the latter than the former. Hence the deduction that manufacturers, who have been content simply to transfer to steel the rules they have been in the habit of using for iron, have thereby involved themselves in serious error.

With regard to the other subject, the hardening and tempering of steel, the Institution have just published some very interesting researches made for them by Prof. Abel, C.B., F.R.S., and also by Prof. Chandler Roberts, F.R.S. The former has shown, by the analysis of thin disks of hardened and unhardened steel, the high probability that in unhardened steel the carbon is present as a definite carbide of iron (probable composition Fe_6C_3), eliminated from the iron in a more or less crystalline form; that on heating, this compound is dissolved in, or assimilated by, the metal; and that sudden cooling does not allow time for the elimination to take place, the carbide thus remaining dissolved, more or less completely, and giving a corresponding degree of hardness to the mass. Prof. Chandler Roberts' researches bear on a suggestion which had been made, that the hardening of steel was connected with the occlusion and exclusion of gases by

the metal, in the process of heating and cooling. This he has shown to be unfounded, by heating steel (previously deprived of all occluded gas) to bright redness in a vacuum tube, and then plunging it in mercury, when it was found to harden just as usual. The same followed when a coil of wire was heated *in vacuo* by an electric current, to expel the gas, and then quenched in mercury.

The first paper read was by Mr. J. J. Tylor, on meters for registering small flows of water. The many forms of water meter in use are sharply divided into two classes: piston meters, in which the water is made to flow into a cylinder under a piston, and to escape when the cylinder is full, the number of cylinderfuls being measured; and inferential meters, in which the water is made to turn a fan of some kind, presumably at the same speed as that of the water itself, and the number of revolutions of this fan is measured. The latter class has often been supposed to be less reliable than the former, especially when the quantity passing is small; but the paper gives the results of several comparative experiments, which show that an inferential meter is at least as accurate as a piston meter for all except the very smallest flows, and that for these neither form is fully to be depended on. In practice, however, it is found that, even in small tenements, little or no water is drawn at so slow a speed as to render meters unreliable. Various tables were given showing the great advantages of the meter as detecting waste, the amount of which, under our present water system, is enormous. Good reason is given for believing that ten gallons per head per day in small houses, and fifteen in large houses, is an ample allowance for the real wants of the population; and yet twenty-seven gallons per head is the regular supply of the London water companies. This is probably the most gigantic specimen of organised waste in the world. The means of stopping it are well within the compass of science, and the expense would not be very great; but with the present anarchy in everything connected with metropolitan government, it is, we fear, hopeless to expect the matter to receive attention.

To prevent this waste it is not necessary (as Mr. Tylor pointed out in the discussion) to place a meter in every house. Although many Continental towns are supplied on that system, it would be difficult of introduction in London, and it may be questioned (as various speakers did question) whether it would be worth the expense. The "district meter" system practically accomplishes the same end without this difficulty. On this system a meter is connected with a train of clockwork and drum, so as to register the amount of water passed during successive intervals, say of ten minutes each. The consumption in the different districts of a town, each containing some hundred houses, is measured for 24 hours each, by simply placing the recording meter successively on the mains supplying them. If any of the diagrams thus obtained show special anomalies, the cause can be inquired into: for instance, if a district shows a large quantity of water passing in the small hours of the night, it is obvious that there is serious leakage somewhere; and the inspector proceeds to make a nocturnal tour, and to listen at the stopcocks of each house successively, by which means he can soon detect where the fault lies. In instances given by Mr. Tylor, the use of this simple plan had been effectual in reducing the consumption by fully one-half in particular districts. The system has been applied to the Houses of Parliament; and the consumption of water during some of the prolonged debates of last session has thus been recorded for the benefit of posterity.

The second paper was by Mr. A. A. Langley (engineer to the Great Eastern Railway), on the system of dredging introduced by M. Bazin, the celebrated hydraulician, on the rivers of France. Nothing can be more simple than this arrangement. An ordinary centrifugal pump is worked on board the dredger, and a flexible pipe leads from the pump to the bottom of the water, where it terminates in an elbow-shaped nozzle. The sand and gravel is sucked up the pipe, passes through the pump, and is conveyed along an open channel to the side of the dredger, where it falls into a hopper barge or is otherwise disposed of. On this system the water pressure, as will be seen, is used to facilitate the raising of the sand to the surface; whereas in all other dredgers it is a hindrance rather than otherwise. It thus forms an excellent adaptation of scientific principles; and though not applicable for clay or hard ground, is much cheaper and more rapid than other forms in the removing of sand and shingle. It has also the great advantage that it can be worked in rough water, since a moderate rise and fall of the vessel does not affect the flexible pipe.

There is another point of interest in connection with this dredger. When first started at Lowestoft it was found impossible to make it work with anything like speed or economy, owing to the rapid wear of the cheeks and blades of the pump, which were cut by the sand exactly as glass is cut in the sand-blast process. After many trials the evil was stopped by the simple process of protecting the blades of the fan by pieces of thick india-rubber, which from its softness and elasticity yields to the cutting action, and thus escapes much injury itself, while it prevents all injury to the cheeks. This peculiar property of india-rubber has, we believe, been previously utilised in connection with the sand-blast process, but it has never been adopted on so large a scale, and it certainly deserves to be very widely known.

In the course of the discussion Mr. Charles Ball, who has worked a large number of these dredgers, mentioned that he had forced sand thus dredged for a distance of 600 yards through horizontal pipes, by the mere action of the pump. To prevent the silt from settling during its passage along open troughs, he had inserted a light angle iron in an undulating line along the inside of the trough, so as to give the water a continual twisting motion as it travelled onwards. The great difficulty was to prevent the water from ceasing to flow, either from the sand accumulating above the pump, or from old sacks and other rubbish choking the nozzle. The former was got over mainly by making the discharge-pipe horizontal, and giving it a siphon bend, which kept the water always within it, and prevented any difficulty in starting the pump; and the latter by making openings in the nozzle, just above the grating, which were covered by an indiarubber band having slits in it. When the grating got choked and a vacuum began to form inside the nozzle, these slits opened to the pressure, and allowed the water to flow in.

The third paper was by Mr. E. B. Ellington, on hydraulic lifts for passengers and goods. The risks which attend the use of ordinary chain lifts were minutely described, and also the way in which these are removed by the use of direct acting hydraulic lifts, in which the cage rests on the top of a column of pressure-water, both in ascending and descending. The chief difficulty with such lifts is to balance the dead weight of the cage and attachments, so as to save the needless expenditure of power in raising these each time; and an ingenious arrangement of hydraulic cylinders is described, by which this is attained without the use of counter-weights or chains. A table of experiments on lifts of this and other types is given, which shows the efficiency to be very high, ranging from 75 to 80 per cent. The discussion on this paper was adjourned, for want of time, to the next meeting.

THE CHEMISTRY OF BAST FIBRE[1]

IN a previous paper (see *Chem. News*, 43. 77, and *Chem. Soc. Jour.* xxxviii. 666) the authors established the following points:—The chemical similarity between the non-cellulose constituents of monocotyledonous and dicotyledonous fibres; the resolution of the jute fibre by chlorine into cellulose (using this word in a general sense), and the chloroderivative of an aromatic body, $n\{C_{19}H_{18}Cl_4O_9\}$; all bast fibres examined (flax, hemp, manilla, esparto, &c.) yielded a similar body; the reactions of this substance suggested the hypothesis that it was a complicated derivative of tetrachlorquinone; jute fibre was resolved by boiling dilute hydrochloric or sulphuric acid into a soluble carbohydrate and an insoluble compound of the aromatic body with the more stable form of the cellulose; dilute nitric acid resolves the fibre into cellulose and a nitroderivative of the aromatic constituents $n\{C_{25}H_{31}(NO_2)O_{23}H_8\}$; no constituent of the nature of pectose was found. From these facts the authors drew the conclusion that jute fibre consists of cellulose intimately associated with a complicated body allied to the quinones, in fact, a *cellulide* after the type of the glucosides, the aromatic body being united to cellulose in place of glucose. They also observed that the chlorinated body, when treated with a solution of sodium sulphite, develops a magnificent purple colour; this reaction was applied for the detection of bast fibres. In the present paper the authors have continued this line of research. To the aromatic constituent of the jute fibre the authors assign the formula $C_{19}H_{22}O_9$. The resemblance of this formula to that of catechin, $C_{19}H_{18}O_8$, $3H_2O$, suggested a comparative investigation of the latter substance; both catechin and catechu-

[1] Abstract of papers by C. F. Cross and E. J. Bevan at the Chemical Society, January 19.

tannic acid yielded a chlorine derivative resembling that mentioned above, which gave a brilliant magenta colour with sodium sulphite. Moreover, from a specimen of jute fibre which had become rotten through shipment in a damp state, a body was extracted having all the properties of a tannin. Esparto resin, when fused with potash, furnished phloroglucin and much protocatechuic acid. The general identity of these non-cellulose constituents with the class of astringent substances or tannins is thus fully established.

The authors then give details as to the bromine and chlorine compounds obtained from Esparto resin; they next investigate the action of caustic alkalies on the chlorine derivative $C_{19}H_{18}Cl_4O_9$ of jute-fibre, by which action two atoms of chlorine were removed, as is the case with chloranil. By the action of bromine on jute-fibre a brominated compound was obtained similar to that from Esparto resin. As regards the constitution of these derivatives the authors are inclined to believe that their molecule is built up round chloranil as a centre. Chloranil, when boiled with sugar, forms a brown substance which behaves with alkalies and chlorine exactly like the aromatic substance obtained from bast fibres.

The authors next consider the wider problem of the relation of the cellulose to the non-cellulose constituents of bast-fibres and the relation of both to the life of the plant. In these points they have been anticipated by the investigations and inferences of the physiological botanists Sachs, Sachsse, &c., who have stated that cellulose is directly derived from starch or its physical equivalents sugar, fat, or inulin, and is not a product of the resolution of a proteid molecule; this formation of cellulose is attended with the evolution of carbonic anhydride. The chemical changes are expressed by Sachsse thus:—

$$n(C_{36}H_{60}O_{30}+{}_{30}O)=n({}_{30}CO_2+{}_{24}H_2O+C_6H_{12}O_6);$$

the molecule $nC_6H_{12}O_6$ is then transformed into substances having the atomic ratio $C_6H_{10}O_5$. The formation of cellulose usually occurs in those portions containing no chlorophyll; the formation of starch, on the other hand, is associated with the presence of chlorophyll and the evolution of oxygen. The lignification of fibres originally consisting of pure cellulose is held by Sachs to be a modification of the cell-substance (cellulose), and not an infiltration of substances from the contents of the cell. This change is expressed by Sachsse thus:—

$$\underset{\text{Cellulose}}{C_{24}H_{40}O_{20}}=5H_2O+\underset{\text{Lignin}}{C_{18}H_{24}C_{16}}+C_6H_6O_5.$$

Sachsse thinks that it is to this more highly oxidised molecule $C_6H_6O_5$ that the origin of the tannins is to be referred. The authors dissent from this equation, and think that bodies resembling metapectic acid $C_8H_{14}O_9$ are formed. Such bodies have been found by Kolbs in linen-fibre, and by the authors in the portions of the jute-fibre near the roots (jute-cuttings). Sachs maintains that the tannins are degradation products of cellulose and are to be looked upon as excreta, like urea in the animal. If now the extreme terms of the developmental series are the cellulose and the tannins, it devolves upon the chemist to investigate the intermediate stages of the transformation. The authors therefore treated jute fibre with dilute (5 per cent.) sulphuric acid at moderate temperatures; as a result of these experiments they conclude that the jute fibre consists for the most part not of cellulose, but of a transition form between the original carbohydrate and its ultimate modification of a soluble astringent. To this transitional modification the authors give the name of *bastose*, as the authors consider there are many celluloses, so also there will be many forms of bastose. The aromatic derivatives derived from these bastoses the authors propose to call *bastins*. The authors then adduce various arguments to prove that the conversion of carbo-hydrates into aromatic bodies is possible. Thus Hoppe Seyler, by heating starch to high temperatures with water, formed pyrocatechin. Gun cottons or nitrocelluloses degrade spontaneously into bodies of the pectic class, and the authors, by the action of strong sulphuric acid on dextrin at 7 per cent., obtained a black substance which furnished a chlorinated product resembling in its properties the chlorobastin previously described. The formation of the black substance was accompanied with that of acetic and carbonic acids. The authors conclude the paper with the results of several miscellaneous researches bearing on the subject. The stony concretions of pears can be converted into cellulose, and a chlorobastin giving the colour reaction with sodic sulphite. The origin of tannins, the reactions of jute substance under high pressure, the reduction of indigo by jute, the reaction of linseed oil with sulphuric acid, and additional observations on the chlorobastins, are the titles of these miscellaneous researches. The authors finally embody their results in a diagrammatic survey or genealogical tree: Carbonic anhydride and water, by the action of light, protoplasm and chlorophyll, form starch; starch and oxygen during the growth of the plant give off CO_2 and H_2O, pectin and cellulose being formed. The starch passes through bastose to bastin. Bastose can be split up in various ways by chlorine into cellulose and chlorobastin, by dilute sulphuric acid into furfurol, acetic acid, &c., and tannins (insoluble) by decay into pectic acid, and tannins (soluble) by nitric acid into cellulose and a nitro body. Bastin, by fusion with KHO, furnishes phloroglucin and protocatechuic acid, and by chlorination carbonic acid and chlorobastin.

NOTES FROM THE OTAGO UNIVERSITY MUSEUM

I.—*On a New Method of Preserving Cartilaginous Skeletons and other Soft Animal Structures*

ON reading Professor Miall's account of the employment of glycerine jelly for the preservation of anatomical preparations (NATURE, vol. xviii. p. 312), it occurred to me that many of the more solid and less complicated structures, usually kept in spirit, might possibly be preserved by thoroughly impregnating them with glycerine jelly and then allowing them to dry. I was able to make very few experiments in this direction before leaving England, but during the present year I have tested the method I am about to describe enough to make me feel tolerably confident in recommending it as of especial value for cartilaginous and partially ossified skeletons, and useful also for such things as hearts, stomachs, and other viscera, and for the exoskeletons of Crustacea, Echinoderms, &c.

I will first describe the method adopted in preparing the skeleton of a fresh Elasmobranch. The fish is eviscerated, the gills removed and placed in strong spirit, and the body plunged into water a few degrees below the boiling point. An immersion varying from a few seconds to a few minutes serves to soften the muscle and connective tissue to such an extent that they can readily be stripped from the cartilage without injury to the latter. This I find the only satisfactory way of cleansing many parts of the elasmobranch skeleton, notably the vertebral column. In the case of the gills even a momentary immersion in hot water is liable to cause a separation of the cartilages; they are therefore best prepared in the cold, after the ligaments have been well hardened with alcohol. After the remainder of the skeleton is cleansed it may either be put through the preserving process at once, or previously hardened in alcohol—the latter alternative is the best, since it diminishes subsequent shrinking, but it is not essential and may very well be dispensed with in the case of large skeletons, for the sake of saving the otherwise large expenditure of alcohol. I need hardly say that it is always advisable to separate the skull from the vertebral column, the pectoral fin from the shoulder girdle, &c., as in this partially disarticulated condition the skeleton is more easily manipulated, besides being more convenient for future use. In the case of large sharks it is also necessary to divide the vertebral column into pieces small enough for the vessel used in the preserving process.

The various parts of the skeleton, with or without previous hardening in alcohol, are then placed in "glycerine fluid" of the following composition:—

Glycerine	1 litre.
Water	1 ,,
Alum	20 grm.
Corrosive sublimate	10 ,,

This fluid is a modification of Wickersheimer's, the chief alteration being the omission of alcohol: the alum may also be omitted if the specimen has been hardened with alcohol. After remaining in the fluid until thoroughly permeated—two days to a week, according to size—the skeleton is transferred to the following glycerine jelly:—

Gelatine	150 grm.
Glycerine	1 litre.
Water	1 ,,
Corrosive sublimate	10 ,,

The jelly is kept at a heat just sufficient to melt it, in an earthenware vessel (neither the glycerine fluid nor the jelly should be allowed to come in contact with metal), over a water

bath, and the specimen is retained in it for about three or four days. It is of course advisable to have vessels of various sizes, so as not to use more jelly than is absolutely necessary. I find that a small pudding-basin, a vegetable-dish, a soup-tureen, and an earthenware foot-bath form a very useful set of vessels; a galvanized iron wash-tub serving as an excellent water bath. For ordinary purposes I use gelatine-glue instead of pure gelatine, the former being only one-fourth the price of the latter. Phenol may be substituted for corrosive sublimate.

After removal from the glycerine the specimen is thoroughly drained, and placed in a dry room protected from the dust. Such parts as the vertebral column, the fins, and, in most cases the skull may be left to dry without further care, but thick or strongly curved structures, such as the jaws and shoulder girdle, should be fastened out while drying with strappings of tape, small wooden or cardboard supports, &c., as otherwise a certain amount of twisting is inevitable.

When no more shrinking or "buckling" is perceptible—it is generally advisable to allow some weeks for this—the specimen is varnished with a solution of white shellac in rectified spirit. This should be done in a warm room, as the slightest damp produces precipitation of the shellac. After two or three coats of this varnish the cartilage is found to have a dry and smooth but not too glossy surface.

In mounting the skeleton the best way is to support each part separately on a light wire cradle, so that it can at any time be removed for examination. If it is found necessary to articulate any of the parts, it is advisable to use platinum wire.

In preparing the chondrocranium of Teleostei (*e.g.* Salmo) it is again advisable to have recourse to parboiling: the membrane bones can then be easily removed and the cartilaginous brain-case, Meckel's cartilages, and the branchial arches prepared as above. Skeletons of earlier mammalian fœtuses must be put through the process *in toto*, the chief disadvantage of this method being that the bones, being impregnated with gelatine, never become very white. In later fœtuses the epiphyses of the long bones and other cartilages are readily removed, and may then be prepared separately. In disarticulating mammalian skulls it is a good plan to remove the mesethmoid and prepare it in the above method, thus preserving an important part of the skull which the student, as a rule, never sees unless he takes the trouble to dissect it out for himself.

Up to the present time my two assistants—to whose care and patience it is only right that I should express my indebtedness—have prepared entire skeletons of Carcharodon, Cestracion, Raja, Ceratodus, and calf fœtus, chondrocrania of Alopecias, Acanthias, Salmo, and Petromyzon, and mesethmoid of the sheep. Some of these have now been prepared for several months, and the small amount of shrinkage may be gathered from the fact that an entire skeleton of Ceratodus lost only 1-36th of its length, and that the membrane bones of the Trout, which were separated from the chondrocranium before the preparation of the latter, fitted afterwards into their places with great accuracy. I have not yet, however, been thoroughly successful with the jaws of the Elasmobranchs, as hitherto there has always been a slight cracking of the superficial calcareous crust, which in the jaws is much thicker than elsewhere; but as this is sometimes seen, to a slight extent, even in spirit specimens, I do not at present see how to prevent it entirely. With purely cartilaginous structures the success of the method is very marked: for instance, the gill-arches of Cestracion and of Raja, prepared with the delicate branchial rays, and in the former genus, the extra-branchial cartilages have, after several weeks, their flexibility and translucency unimpaired.

Other organs, for the preservation of which I have found this method successful, are hearts, stomachs, intestines, &c. Even the entire alimentary canal with the liver spleen and pancreas of, for instance, a skate, may be prepared with a tolerable amount of success. All these soft parts must, of course, be first thoroughly hardened with alcohol or chromic acid. I have also obtained a fairly good preparation of the skate's brain *in situ* with the intracranial portions of the cerebral nerves, but as far as my present experience goes, I hardly think that my method is likely to be as successful as Giacomini's for brains (*Journ. of Anat. and Phys.*, January, 1879).

I may mention that I have tried a modification of Giacomini's method for cartilaginous skeletons, but hitherto have not found it so successful as the glycerine jelly process.

I have had some little success in preserving Crustacea, Echinoderms, &c., so as to retain their natural colour and flexibility, but further experiments are wanted in this direction. I have also made one or two attempts to apply the method for the preparation of skins of fishes, amphibia and reptiles for stuffing: the few experiments already made show a distinct improvement upon the ordinary dried skins, both in the preservation of the natural colour and in the diminution of shrinking. Some modification of the process may possibly be useful for the wattles, &c., of birds. In spite of the obvious objections to stuffed specimens, they could be ill-spared in a public museum, neither skins nor spirit specimens being suited to replace them, and it would certainly be an advance in museum technique, if, for instance, the ordinary brown, shrivelled, and highly varnished specimens of fishes could be replaced by something a little more life-like.

T. JEFFERY PARKER

Dunedin, N.Z., November, 3rd, 1881

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—In a Convocation held on February 7 the sum of 250*l.* was voted to the Linacre Professor for apparatus for the Physiological Laboratory.

Dr. T. K. Chambers, Christchurch, has been nominated to represent the University in the General Council of Medical Education in place of the late Prof. Rolleston.

The Curators of the Bodleian library have elected Mr. E. W. B. Nicholson, M.A., of Trinity College, as Bodley's Librarian in place of the late Mr. Coxe.

The Examiners for the Burdett Coutts Geological Scholarship have given notice that the examination will be held on Monday, February 27 and three following days, at 10 a.m. The scholarship is tenable for two years, and is open to all members of the University who have passed the necessary examinations for the degree of B.A., and shall not have exceeded their twenty-seventh term.

SCIENTIFIC SERIALS

Journal de Physique, January.—On the limits of electrolysis, by M. Berthelot.—Note on Prof. Clerk Maxwell's memoir on the theory of maintenance of electric currents by mechanical work without using permanent magnets, by M. Brillouin.—Experimental researches on Purkinje's phenomenon, by MM. Macé de Lepinay and Nicati.—Varnish for writing on glass, by M. Crova.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti, vol. xiv. Fasc. xviii.-xix.—Zoological annotations, by Prof. Pavesi.—On protistological analysis of drinking water, by Prof. Maggi.—Another case of a single kidney in man, with incomplete development of the spermatic vesicle and the prostate on the defective side, by Prof. Sangalli.—Vines and their enemies in 1881, by Prof. Garovaglio.—On some fossils of the Upper Jurassic found in the western Venetian Alps, by Dr. Parona.—Experimental researches on the physiological and therapeutic action of cocaine, by Prof. Morselli and Dr. Buccola.—Reduction of integrals of algebraic functions to integrals of rational functions, by Prof. Formenti.—The double quadratic transformation of space and its application to the non-Euclidian geometry, of space, by S. Aschieri.

Fasc. xx.—Reports on works presented and on prize competitions, also announcement of prize subjects.

Atti della R. Accademia dei Lincei, vol. vi. fasc. 3.—New series for expressing the heliocentric coordinates in function of the mean anomaly, by S. de Gasparis.—Contribution to the anatomy of leaves, Part II., by S. Briosi.—On the present regression of glaciers of the Alps, by S. Stoppani.—Reports on prize competitions. The royal prize in biology (10,000 lire) is divided between Prof. Mosso and Prof. Trinchese, the work of the former being sphygmographic researches on the circulation of the blood in the human brain; and that of the latter on Italian maritime fauna (describing several new species), and on the early development of mollusca. The Royal prize in mineralogy and geology (10,000 lire) is awarded to Prof. Taramelli, for a work on the geology of the Venetian province. In physical science Prof Poloni is awarded a prize of 1500 lire, for a memoir on the permanent magnetism of steel at different temperatures.—The salient features of these and other memoirs are noted.

Vol. xi. fasc. 4.—Researches on movements of the intestine, by Signori Mosso and Pellacani.—On the action of halogenated

organic radicals on the potassie compound of pyrol, by Signori Ciamician and Dennatedt.—Contributions to the anatomy of leaves (continued), by S. Briosi.—On linear differential equations, by S. Casorati.

La Natura, January, 1882.—Considerations on some relations between the velocity of efflux, the specific heat, and the mean squares of the molecular velocity of gases, by Dr. Nachs.—On the rapidity with which light modifies the electric resistance of selenium, by Prof. Bellati and Dr. Romanese.—On the products of electrolysis of various acid and alkaline solutions, with graphite electrodes, by Dr. Bantoli and Regrasogli.

SOCIETIES AND ACADEMIES

London

Royal Society, December 8.—"The Vibrations of a Vortex Ring, and the Action of Two Vortex Rings upon each other." by J. J. Thomson.

The first part of the paper contains a discussion of the vibrations which can occur in the figure of a vortex ring, whose cross-section is small compared with its aperture. It is proved that if the equations to the circular axis of a vortex ring are—

$$\rho = a + a_n \cos nt$$
$$z = \beta_n \cos nt$$

ρ being the distance of a point on the circular axis from the straight axis, and z the distance of the point from the mean plane of the circular axis, then—

$$a_n = A \cos\left(\frac{\omega e^2}{2a^2} \log \frac{2e}{a} n \sqrt{n^2-1}\, t + B\right)$$
$$\beta_n = A \frac{\sqrt{n^2-1}}{n} \sin\left(\frac{\omega e^2}{2a^2} \log \frac{2e}{a} n \sqrt{n^2-1}\, t + B\right)$$

where ω is the angular velocity of molecular rotation, and e the the radius of the cross-section of the vortex core; e is small compared with a.

Thus the time of vibration for such a displacement in the circular axis is—

$$2\pi / \frac{\omega e^2}{2a^2} \log \frac{2e}{a} n \sqrt{n^2-1}$$

or if T be the velocity of the vortex—

$$= 2\pi a / Tn\sqrt{n^2-1}$$

This shows that a vortex ring with small cross-section of core is stable for all displacements of its circular axis. Sir W. Thomson has proved that it is stable for all alterations in the shape of the cross-section of its core.

The second part of the paper contains an investigation of the action of two vortices upon each other when the shortest distance between them is large compared with the diameter of either of the vortices. The amount of the disturbance each vortex experiences is worked out in the paper, but it may be sufficient to quote here the general effect of the collision which is given by the following rule:—the vortex which first passes through the point of intersection of the direction of motion of the two vortices is deflected towards the direction of motion of the other, it increases in radius and energy, and its velocity of translation is diminished, the other vortex is deflected in the same direction as the first, it diminishes in radius and energy, and its velocity of translation is increased.

"On Melting Point." By E. J. Mills, D.Sc., F.R.S. (Abstract.)

The author gives a list of twenty-three aromatic compounds, the melting-points of which he has determined in terms of the air thermometer. The average probable error of a single result is about 0°·015. The numbers obtained, which range from 42° to 121°, obviously represent a set of thermometric standards, free from most of the grave inconveniences presented by the ordinary mercury-glass thermometer. In some cases they are shown to be proportional to the numerical value of the formula, a law which, it is suggested, may be in the limit the real law of melting-point. The original memoir contains a full description of apparatus and methods.

Royal Society, January 12.—"On the results of Recent Explorations of Erect Trees containing Reptilian Remains in the Coal Formation of Nova Scotia," by J. W. Dawson, C.M.G., LL.D., F.R.S., &c.

The explorations referred to were carried on chiefly in the beds at Coal Mine Point, South Joggins, Nova Scotia; and their object was to make an exhaustive examination of the contents of erect trees found at that place and containing remains of Batrachians and other land animals.

A detailed section is given of the beds containing the erect trees in question, with lists of their fossil remains. The most important part of the section is the following:—

	Ft.	In.
Sandstone with erect *Calamites* and *Stigmaria* roots	6	6
Argillaceous sandstone, *Calamites*, *Stigmaria*, and *Alethoptiris Cuchitica*	1	6
Gray scale, with numerous fossil plants, and also *Naiaidites*, *Carbonia*, and fish scales	2	4
Black coaly shale, with similar fossils	1	1
Coal, with impressions of *Sigillaria* bark	0	6

On the surface of the coal stand many erect *Sigillaria*, penetrating the beds above, and some of them nearly three feet in diameter at the base and nine feet in height. In the lower part of many of these erect trees there is a deposit of earthy matter, blackened with carbon and vegetable remains, and richly stored with bones of small reptiles, land snails, and millipedes. Detailed descriptions of the contents of these trees are given, and it is shown that on decay of the woody axis and inner bark they must have constituted open cylindrical cavities, in which small animals sheltered themselves, or into which they fell and remained imprisoned. These natural traps must have remained open for some time on a sub-aerial surface.

In all twenty-five of these erect trees had been discovered and extracted, and the productive portions of them preserved and carefully examined. Of these fifteen had proved more or less productive of animal remains. From one no less than twelve reptilian skeletons had been obtained. In a few instances not only the bones, but portions of cuticle, ornamented with horny scales and spines, had been preserved.

The Batrachians obtained were referred to twelve species in all. Of these two were represented so imperfectly that they could not be definitely characterised. The remaining ten were referable to the two family groups of *Microsauria* and *Labyrinthodontia*.

The *Microsauria* are characterised by somewhat narrow crania, smooth cranial bones, simple or non-plaited teeth, well-developed limbs and ribs, elongated biconcave vertebræ, bony scales and plates on the abdomen, and horny scales, often ornate, on the back and sides. They show no traces of gills. The species belonging to this group are referred to the genera *Hylonomus*, *Smilerpeton*, *Hylerpeton*, and *Fritschia*. The characters of these genera and of the several species are given in detail and illustrated by drawings and photographs, including microscopic delineations of the teeth of all the species, with their internal structure and the microscopic structure of their bones, as well as representations of their cuticular ornamentation and armour.

The Labyrinthodonts are represented by only two species of *Dendrerpeton*, which are also described and delineated.

About half of the reptilian species described are new, and those previously described from fragmentary remains are now more fully characterised, and their parts more minutely examined.

The invertebrate animals found are three species of land snails and five of myriapods, besides specimens supposed to represent new species of myriapods and insect larvæ, not yet fully examined, and which have been placed in the hands of Dr. Scudder, of Cambridge, U.S.

The memoir, consisting in great part of condensed descriptions of the facts observed, does not admit of much abridgment, and cannot be rendered fully intelligible without the accompanying plans, sections, and drawings. It closes with the following general statement:—

"The negative result that, under the exceptionally favourable conditions presented by these erect trees, no remains of any animals of higher rank than the *Microsauria* and *Labyrinthodontia* have been found deserves notice here. It seems to indicate that no small animals of higher grade inhabited the forests of Nova Scotia at the period in question; but this would not exclude the possibility of the existence of higher animals of a larger size than the hollow trees were capable of receiving. Nor does it exclude the possibility of higher animals having lived contemporaneously in upland situations remote from the low flats to which our knowledge of the coal formation is for the most part confined. It is to be observed also that as some of

the reptilian animals are represented only by single specimens, there may have been still rarer forms, which may be disclosed should other productive trees be exposed by the gradual wasting of the cliff and reef."

Physical Society, Jan. 28.—Dr. Stone, in the chair.—New Member, Mr. W. Lant Carpenter.—Mr. T. Wrightson read a paper by himself and Prof. W. Chandler Roberts, F.R.S., on the fluid density of metals. The results were obtained by the process described in a former paper to the Society, on the fluid density of bismuth. The mean results were for copper, 8·217; lead, 10·37; tin, 7·025; zinc, 6·487; silver, 9·51; iron (No. 4 Foundry, Cleveland), 6·88. These results are slightly less than those given by Mallet's process, but they are sufficiently close. For bismuth the fluid density found by the authors is 10·055, which is slightly more than that given by Mallet's method (9·82). The authors consider their method satisfactory. It consists in suspending a ball of the solid metal from a spiral spring, and allowing it to dip into a crucible of the same metal in a molten state. The movements of the spring as the ball melts are recorded by a pencil on a band of travelling paper.—Mr. C. Vernon Boys read a paper on apparatus for calculating efficiency. The object of such machines is to automatically divide and continuously record the quotient of the speeds with which two things are turning. If the two things are the records of two of Boys' integrating machines (previously described to the Society), one finding work put into, and the other work sent out from any combination of mechanism, then the quotient gives the efficiency of the combination. If one measures work or current, and the other time or turns of a machine, the quotient measures the value of horse-power per hour or current per turn. Mr. Boys described four machines of the kind acting on two principles, from which he names them logarithmic and harmonic dividers. They all derive their actions from motions of pure rolling The simplest is made by hanging a magnetised steel reel on to a pair of iron cones, which are turned by integrators. The reel travels about and continuously shows the value of the quotient.—Mr. Boys then read a paper on a *new current meter*. The rate of a pendulum clock depends on gravity, and is proportional to the square root of the strength of gravity. That of a watch depends on the strength of the hair-spring, and is proportional to the square root of its strength. The force due to an electric current is proportional to the square of the current strength. Hence if part of an electric circuit is capable of vibrating under electromagnetic force, the speed of vibration will be proportional simply to the current strength, for the square of the speed measures the force, and the force is proportional to the square of the current. If, then, such a contrivance takes the place of the balance of a pendulum-clock, the clock will measure electric currents instead of time. To keep the indications true, the maintaining power must be so contrived that the amplitude does not vary much, or the parts must be so arranged that the force is directly proportional to the displacement. Mr. Boys showed several ways of producing a controlling power. The first was a combination of solenoids, one passing through the other, and in which the force was proportional to the displacement. Being without iron, it applies to the case of alternating currents. In another a small armature is mounted on the balance staff, and around it are the two poles of an electromagnet, which forms part of the circuit. In a third form, which is unaffected by residual magnetism, two crescent-shaped pieces of iron forming the sides of the balance pass through two fixed solenoids. In all these cases the direction of the current does not matter. The maintaining power may be any ordinary escapement drawn in the usual way. It may also be independent of clockwork, an impulse being given to the balance electrically at each swing. A meter of this kind was shown in which the controlling power depends on iron crescents and solenoids, and in which a portion of the main current is shunted through secondary solenoids when the balance is in its neutral position; at which time a variation in the currents in the controlling solenoids has no effect in disturbing the period of oscillation. Such a meter is regulated by an adjustible weight, if it goes too fast or slow. Being independent of gravity it will work equally well anywhere. Prof. John Perry thought Mr. Boys' devices very promising, and mentioned that Prof. Ayrton and he had invented a very simple current meter not yet described. Dr. Coffin pointed out that electric clocks of a certain class were really current meters. Prof. Guthrie remarked that in Mr. Boys' meter practically no work was taken from the current. Reference was made by Dr. Stone and Mr. Lecky to Hipps' clocks, the latter testifying to their efficiency.—Capt. Abney, R.E., then exhibited some experiments on the phenomenon of phosphorescence. Balmain's luminous paint, calcium sulphide, and other substances give out a violet light after having been excited by daylight. Capt. Abney found that when the spectrum was allowed to fall on an excited surface of Balmain's paint the blue rays enhanced this violet light, and the red end of the spectrum extinguished it. This was shown to the meeting, and the red end of the spectrum appeared on the paint in well-defined black bands. Similarly, the light from an electric lamp passed through a sheet of red glass extinguished the phosphorescence. Capt. Abney's researches further showed that there is a series of octaves in the blue end of the spectrum which refuse to quench the violet light. He found the mean wave-length of the rays exciting the phosphorescence to be 4300. Prof. Guthrie also showed that calcium sulphide tubes glow in violet light.

Anthropological Institute, January 10.—Major-General Pitt-Rivers, F.R.S., president, in the chair.—Hugh Felvey and Mrs. Bathoe were elected Members of the Institute.—Mr. Bryce-Wright exhibited a series of sixteen portraits of the Incas, copied from the originals in the Temple of the Sun.—Mr. Worthington G. Smith exhibited some stone implements from the north-east of London.—General Pitt-Rivers, F.R.S., read a paper on the entrenchments of the Yorkshire Wolds, and excavations in the earthwork called Dane's Dyke, at Flamborough. At Dane's Dyke the author had found flints and flint flakes, clearly proving that the constructors and defenders of the earthwork used flint, and lived not later than the bronze period. The whole district was the scene of the operations of a people much earlier than the Danes, and therefore the term "Dane's Dyke" was a misnomer.—In the absence of the author the Director read a paper by Mr. J. R. Mortimer, on the discovery of ancient dwellings on the Yorkshire Wolds.

Institution of Civil Engineers, January 24.—Mr. Brunlees, vice-president, in the chair.—The paper read was on "The Analysis of Potable Water, with special reference to the determination of Previous Sewage Contamination," by Mr. Chas. W. Folkard.

SYDNEY, N.S.W.

Linnean Society, November 30, 1881.—Dr. J. C. Cox, president, in the chair.—The papers read were: By the Hon. Secretary, for Baron F. von Mueller, K.C.M.G., on two new species of New South Wales plants.—By J. J. Fletcher, M.A., B.Sc., on the existence after parturition of a direct communication between the median vaginal cul-de-sac, so called, and the uro-genital canal in certain species of kangaroos.—By the Hon. William Macleay, F.L.S., on two new species of snakes from the western interior of New South Wales. Mr. Macleay stated that these new species had been discovered by Mr. James Ramsay, of Tyndarie, near Bourke; they were a new species of *Diemenia*, which it was proposed to call *D. ferox*, and a new species of the genus *Aspidiotes*, named *A. Ramsayi*, after its discoverer.—By the Rev. Wm. Woolls, Ph.D., on the flora of New South Wales, being the sixth paper on this subject by this well-known botanist.—On the Cypreæ of New Caledonia, by Mr. J. C. Rossiter, of Numea, N.C.; communicated through Mr. John Brazier, C.M.Z.S.—On a new species of *Therapon*, *T. Macleayana*.—On two new birds from the Solomon Islands: (1) a kingfisher, *Halcyon salmonis*, allied to *H. chloris*, but without the white nape patch or superciliary stripe; and all the under surface white, the under-wing coverts white, the upper surface of a much brighter blue; (2) a Rhipidura, *R. tenebrosa*.—On the habitats of *Pachycephala olivacea* and *Pycnoptilus floccosus*, and their occurrence near Sydney, by Mr. E. P. Ramsay, F.Z.S., C.M.Z.S., Curator of the Australian Museum.—Exhibits—Mr. Ramsay exhibited specimens of the following new and rare birds from the Island of "Ugi," in the Solomon groups:—1. *Ptilopus Eugeniæ*, Gould. (2) *Ptilopus Lewisi* (Ramsay), similar to *P. Eugeniæ*, but without the white head. 3. *Ptilopus Richardsii* (Ramsay), a very remarkable species, having the head, neck, and breast of a light french grey, tinged slightly with pale olive yellow, the crown is of a very pale lilac, the scapulars beautifully painted with rose down the centre of each feather. 4. *Ptilopus Johannis* (Sclater), said to be identical with *P. ceraseipectus* of Canon Tristram, and of which *P. solomonensis* of Gray is the female. 5. *Chalcophaps mortoni* (Ramsay) resembles *C. chrysochlora*, but has no shoulder patch, and is larger. 6. *Trichoglossus* (*Charmosyne*) *Margarethæ* (Tristram), male and female, the female alone being previously

known, the male differs in having no yellow on the sides of the uropygium, this part being crimson, like the flanks and belly. 7. *Nasiterna finschi* (Ramsay), males and females; the male is distinguished by having a stripe of red down the abdomen, and the feathers round the lower mandible more distinctly tipped with blue; *Rhipidura tenebrosa* (Ramsay) being of a dull olive brown, with a few white-tipped feathers on throat and sides of the head.—Dr. J. C. Cox, F.L.S., exhibited several specimens of wood carvings from the Solomon Islands; also two drills used by the natives of Ruhiana in building their canoes, and a fish-trap made of cordage, used by the natives of the same island.—Mr. Brazier exhibited a very fine collection of Cypræa, viz.:—*Cypræa hirundo* 2, *neglecta* 2, *cylindrica* 2, *errones* 3, *moneta* 4, *lynx* 5, var. *Caledonica* 1, *Isabella* 1, *caurica* var. *obscura* 3, *stolida*, var. *Crossei* 2, *Arabica* 7, *vitellus* 4, *scurra* 1, *staphylæa* 1, *mappa*, var. *nigricans* 2. These fourteen species were all distorted or malformed, with the extremities rostrated, and the base arched. Three fine varieties of *C. tigris*, four fine varieties of *C. crebaria*, and one fine pink variety of *C. mappa*. These three species are normal.—The Hon. William Macleay exhibited dried specimens of the two plants described by Baron Müller, also a large peculiarly-shaped gall of a manna-producing coccus on a gumtree branch, and a rare heteromerous beetle (*Zopherosis Georgii*), both sent by Mr. Palmer. Mr. Macleay also exhibited some samples of a bark said to be used by the natives of New Caledonia and New Hebrides to procure abortion, and a mass of a kind of gutta-percha from a new Caledonia tree. These two exhibits were sent by Mr. E. L. Layard, C.M.G., British Consul, Noumea. Mr. Fletcher exhibited a large number of microscopic sections. A special vote of thanks was awarded that gentleman for his very valuable paper on the uro-genital organs of the kangaroo.

Paris

Academy of Sciences, January 30.—M. Jamin in the chair.—The following papers were read:—On the theory of repeated proofs, by M. Bertrand.—On some applications of the theory of elliptic functions, by M. Hermite.—On a criticism in the last number of *Memoirs* of the Italian Society of Spectroscopists (p. 256), by M. Faye. M. Tacchini says there is not perfect parallelism between spots and protuberances. M. Faye (who regards these phenomena as in mechanical connection) contends that from the nature of the observations this is not to be looked for, but merely a general accord.—*Résumé* of meteorological observations made during 1881 at four points of Haut-Rhin and the Vosges (continued), by M. Hirn. The great excess of water which falls in the higher regions is met by the useful regulative action of mountain forests; and disastrous results have followed the extensive destruction of wood on the Vosges.—On various problems of relative motion, by M. Gilbert. He analyses the action of M. Sire's polytrope, gyroscopic pendulum, &c.—On the hematic crisis in acute maladies with sudden defervescence, by M. Hayem. This crisis, occurring near the end of acute disease, is chiefly characterised by a temporary increase of hematoblasts in the blood; in forty-eight hours their number is nearly doubled; in twenty-four hours more it diminishes considerably, and ere long the normal state is recovered, in which there is about one hematoblast to twenty red corpuscles. The abnormal ratio between these elements at the time of greatest accumulation of hematoblasts is represented nearly always by the same figure (seven on the average; variation limited between eight and six). The hematic crisis indicates an effort of sanguineous reparation.—On a class of binomial linear differential equations with algebraic coefficients, by M. Appell.—The death of M. Billet, Correspondent in Physics, was announced.—On the oscillatory character of the cause producing the variable distribution of spots on the sun's surface, by M. Spoerer (with annotations by M. Faye). M. Spoerer's data (here tabulated) with M. Carington's, prove that the sun-spot activity (which is concentrated between 6° and 35°) advances slowly from 35° towards the equator, increasing to a maximum at 18°; then proceeds, with diminution, to 5° or 6°, where it disappears. A new cause now brings out some spots in the higher latitudes again, and the same series is reproduced. M. Spoerer calls attention also to an alternating preponderance of each hemisphere in production of spots (but this is less marked).—On asymptotic integrals of differential equations, by M. Boussinesq.—On the generation of surfaces and curves with double curvature of all degrees, by M. Vanecek.—On the combination of carbonic acid and water, by M. Wroblewski. His results obtained in compressing and liberating carbonic acid in contact with water, point he thinks, to the existence of a hydrate of carbonic acid, easily dissociable, and producible by pressure (like M. Ogier's chlorhydrate of phosphide of hydrogen). The critical pressure which must be produced in order to the phenomenon occurring is the tension of dissociation of the hydrate formed.—Silicomolybdic acid, by M. Parmentier.—On new combinations of aldehydes with iodide of phosphonium, by M. de Girard.—On the vapour-density of chloride of pyrosulphuryl, by M. Ogier.—On the formation of an aldehyde-acetone and a glycol of the aromatic series, by M. Burcker.—Researches on pilocarpine, by M. Chastaing.—On the relations of the vasomotor system of the *medulla oblongata* with that of the spinal cord in man, and on the alterations of these two systems in the course of sensitive *tabes*, by M. Pierret.—On the formation of blighted grains of wheat, by M. Prillieux.—Attempt at reproduction of Wollastonite and of Meionite, by M. Bourgeois.—On a multiplying anemometer applicable to measurement of the velocity of wind in mining galleries, to meteorological observations and to determination of the velocity of water-courses, by M. Bourdon. This is a system of convergent divergent tubes. In one such tube, made according to Venturi's proportions, is fixed concentrically a second much smaller, and having its divergent end exactly at the point where the truncated summits of the cones of the larger tube unite. (For very small velocities a third tube may similarly be fixed within the second.) A hollow sleeve is fixed round the union of the truncated cones of the wide tube; its interior communicates with that of the latter and with a manometer, on which the pressure is read. If a manometer at the mouth of the large tube register 1 with a current, the other manometer will register *e.g.* 6; the pressure here is negative and due to acceleration of the velocity of the current.—On some atmospheric phenomena observed during the recent period of high pressures, by M. Vinot. General de Nansouty, on the Pic du Midi, records exceptional purity of sky; the zodiacal light was seen on January 1 (a very rare thing), and the earthshine and thin crescent of the moon, only 25h. 46m. old, were also seen in January.—Observations in a balloon, of the opaque cloud which covered the Paris region for some days, by M. de Fonvielle. The cloud was hardly 300 m. thick. In the upper part the guide rope got covered with hoar-frost. The temperature of the cloud was about 5° below zero.—Relief map of France, on the scale of $\frac{1}{800000}$, by M. Guillemin.

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THURSDAY, FEBRUARY 16, 1882

HYPOTHETICAL HIGH TIDES

IN his interesting lecture entitled "A Glimpse through the Corridors of Time," recently published in NATURE, Prof. Ball, accepting Mr. George H. Darwin's view—that the moon was once part of the earth's mass, and after separation long revolved much nearer to us than now—estimates that when 40,000 miles distant she produced tides 216 times greater than the present, and advances the theory that these high tides have been the most powerful agents in producing changes on the earth's surface. He further presents this theory to geologists as a solution of some of their most difficult problems.

All this is exceedingly interesting if true. There can be no question that a tide of six hundred feet sweeping over all shores and lowlands twice a day would be a most powerful destructive and creative engine; and it may be conceded at once that its potency in remodelling the earth's surface would far surpass any agent of change now in action. Hence we may fairly infer that if such tides had prevailed in former times they should have left behind them universal and indisputable evidence of their existence.

Having studied with some care the geological record in places where it is as nearly complete as anywhere, I must say that I fail to find there any traces of the action of these stupendous tides pictured to the imagination by Prof. Ball. On the contrary the whole of that record, from the Archæan to the present time, offers evidence opposed to such a theory as he proposes.

Of what took place before the *Laurentian* strata were deposited we can gain no knowledge from the rocks, because these are the oldest known. We can only say that they are aqueous sediments of which the materials were derived from pre-existent land. Though much metamorphosed they are plainly the prototypes of the sandstones, shales, and limestones of later formations, and, we may fairly conclude, were deposited under like conditions. In the granites of the Laurentian we apparently have representatives of the coarser sediments formed along shores; the slates are the clays of ancient times, the wash of the land deposited in quiet waters off shore, while the marbles—which in some places form a considerable portion of the Laurentian series—are undoubtedly organic sediments that accumulated in quiet water, deep or shallow, by the slow processes of growth and decay of animal structures. Graphite, the product of plant life—probably fucoidal—exists in large quantities in the Laurentian rocks, and they contain enormous beds of iron ore which must have been accumulated by the aid of organic matter. Hence we may say that in the Laurentian age life was abundant, and much of this was littoral life, and that the vital unites with the physical in opposition to the high tide theory.

The *Huronian* series consists mostly of slates, quartzites (sometimes ripple-marked), and beds of iron ore, all shore and shallow water deposits speaking of quiet times and no high tides.

The *Cambrian* rocks are but imperfectly shown on the eastern side of the North American continent, and we will not stop to inquire minutely into the circumstances of their deposition. We may say, however, in passing, that they contain no really coarse material, and are all, so far as is known, the deposits of quiet waters.

In the *Lower Silurian* series, which is here remarkably complete, we have a record that tells with great clearnes the physical as well as the vital history of the continent in that age.

The *Potsdam Sandstone*, the base of our Silurian, is an old beach spread over large areas of pre-existent land by a slow and quiet subsidence, and the invasion of the sea. The Laurentian highlands, the Adirondachs, the Archean area south of Lake Superior, formed the shores of this sea; and the Ozark Mountains, the nucleus of the Black Hills, &c., were islands in this sea, each with its shore line. The old Potsdam beach is now exposed, and has been examined in hundreds of localities along a line of a thousand miles or more, and there the ancient sea margin can be followed as easily and certainly as we can now meander the line of the Atlantic coast. We everywhere find the history of the old beach written with unquestionable accuracy and in great detail. The strata are frequently ripple-marked and sun-cracked, their surfaces are covered with the interlacing casts of seaweeds, the sand is bored in every direction by annelids, and is full of the fragmentary or complete shells of the beach-loving linguias. This record not only includes no traces of extraordinary high tides, but is full of positive evidence that in the beginning of the Silurian age no tides much higher than at present swept the Atlantic coast of North America.

Above the Potsdam sandstone is spread a great sheet of organic material, the Trenton limestone group, in places a thousand feet thick, the deposits of quiet waters, and composed almost entirely of the hard parts of animals which inhabited them. As we approach the old shores these limestones become more earthy, and in places they abut directly against Laurentian cliffs, which supplied so little mechanical material as to form but a trifling percentage of the deposit made. Here we are on the old shore line, and are surrounded with evidence of the slow and quiet accumulation of material, and the entire absence of any indication of tidal action greater than that of the present day.

The same phenomena teach the same lesson in the records of the Upper Silurian, Devonian, and later geological ages. In the Devonian rocks we have another witness against extraordinarily high tides, for here are coral reefs rivalling those now forming in the tropical seas. Unless the reef-building polyps of the Devonian age were altogether different in habit from those now living, these coral reefs must have been formed in water less than two hundred feet in depth. Here high tides would have wrought the rapid destruction of the whole race of reef-building animals, at the ebb exposing them to the air for hours, and at the flood burying them too deeply for their continued existence. Nearly the same thing is taught by many of our great limestone beds. They are largely made up of mollusks, corals, &c., which inhabit a littoral zone, and it is evident that a tide hundreds of feet in height, sweeping to and fro over that zone, would have rendered it uninhabitable by them.

The sea-weeds now living in our oceans, chiefly occupy

the immediate shore, and most of them grow in a depth of water not exceeding forty feet. It is easy to see that if the present oceans were affected by a movement similar to that described by Prof. Ball, the zone of seaweeds would be the scene of the greatest mechanical violence, and they would be alternately left to dry in the sun, or be torn with irresistible force from their anchorage, and scattered over the land washed by the flood tide. But on every old beach, of which we find so many in the geological series, the casts of the fronds and stems of seaweeds are as plainly discernible as on our present shores. Indeed we may say that of the thousand forms of animal and vegetable life which have their home along the shores of continents, the seaweeds, the boring annelids, the lingulas, the oysters, the barnacles, in short the vast majority of mollusks and all the shore-loving fishes and crustaceans, none could possibly have existed while tides such as have been described prevailed; for that which is now their chosen habitat and the zone of greatest vital activity on the globe, would have been a scene of constant and terrible destruction.

It may also be said that if, as we suppose, the precipitation of ocean waters took place before the corrugations of the earth's surface had assumed any considerable magnitude, and it was nearly or quite covered with water, tidal waves five hundred or more feet in height sweeping over the earth in rapid succession would have worn away the emerging land as fast as it appeared, would have prevented the formation of continents, and have precluded the existence of land animals or plants. And farther, since marine vegetation is practically confined to shallow water, high tides would have rendered the growth of algæ impossible; and as they have supplied the pabulum for marine animal life, it follows that, with tides six hundred feet in height, our globe would have been a lifeless one.

For the reasons cited above, and others that might be given, we are compelled to conclude that the high tides which formed the subject of Prof. Ball's lecture have had no existence during the time covered by the geological record; and further, that since the beginning of that record the order of nature has been essentially what it is to-day. The testimony of the rocks on this subject is so full and conclusive, that it really leaves no room for discussion; and hence the astronomers have been in error in regard to the genesis of the moon, and she never formed a portion of the earth's mass, or the separation took place at a period so remote that she had receded to nearly her present distance before the dawn of life on the earth.

J. S. NEWBERRY

EASY STAR LESSONS

Easy Star Lessons. By Richard A. Proctor. (London: Chatto and Windus, 1881.)

WE have been repeatedly struck by the comparative (it might have been said, more than comparative) ignorance which prevails, even among educated people, as to the nomenclature and position of the stars. There are many who would be grievously scandalised at the idea of not being able to call trees or flowers by their right names, but who seem very little concerned by having to admit a similar incompetency as to the beautiful luminaries of the skies. They would be indignant at the supposition that they did not know an oak from an ash, or could possibly mistake a cowslip for a primrose; but they have no hesitation to confess that they do not know the difference between the two dogs that have been for so many ages keeping guard in the heavens; and if possibly the pre-eminent brilliancy of Sirius, or the magnificent configuration of Orion, may have awakened enough of curiosity to ascertain what they are called, they would still be at an utter loss to discriminate between Capella and Arcturus, or to say in what constellation or at what time they are to look for the Pleiades, whose existence they can hardly ignore. It is not easy to account for such a degree of uninstructed heedlessness. One reason possibly may be, that the knowledge of natural objects which makes its way by such gentle and imperceptible approaches into the minds of intelligent children is acquired by day rather than by night, and that their rambles with parents and nurses in sunshine hours familiarise them insensibly with many things of which they would remain ignorant if they were visible only during their hours of rest. But, however we may try to explain it, so it is, that what was termed in a previous generation the "diffusion of useful knowledge," seems not to have included a popular acquaintance with the sky, and that the maps which were published under that title and to promote that object have been much more serviceable to the express student of astronomy than to educated society in general. Whether such a state of ignorance or *insouciance* may be equally prevalent in other countries we never had an opportunity of ascertaining; but there can be no doubt of it among ourselves, and as little question can be made that it is a discredit to the professed intellectual progess of the age.

Nor can a plausible excuse be fabricated from the want of adequate and familiar help. We pity those indeed who were obliged in former days to gain—or toil after—such knowledge from "exercises" on the celestial globe. Exercises indeed they were, to no common extent, of attention and patience, when some poor child had first of all to learn that left did not mean left, but right, and that she must fancy herself inside the globe to rectify what was drawn all wrong on its outside. This disagreeable and circuitous road to knowledge had indeed its advantages in the solution of problems which are probably less understood in its absence by a subsequent generation; but it was very troublesome, not to say expensive in its machinery, and passed away, to be succeeded by planispheres and delineations of various kinds, and of easier attainment, any of which would have done much towards giving the requisite information, had they been used, or we may say cared for. There was help enough had the want of it been felt as it should have been. But now that astronomy is so decidedly in the ascendant, and takes rank among the prevailing tastes of the age, an opportunity is offered for a fresh attempt, with a fairer prospect of success; and we are glad to find that it has been laid hold of by an author whose name is a sufficient guarantee for his accurate knowledge both of the objects to which he would introduce us, and of the means of delineating them as naturally, and with as little derangement of position, as may be. For it is not every one that knows—though any one may readily convince himself by a trial with the rind of a halved orange—how great is the difficulty of exhibiting a hemisphere on a plane surface, or how much ingenuity is required in arranging a number of planes to

accomplish this end as smoothly and intelligibly as possible. No man has been more successful in this undertaking than Mr. Proctor, whose atlases for telescopic work are well known to observers; and he has now applied the same method to the production of a popular work, the object of which is to give full instruction for the naked eye (if for the eye of childhood, so much the better) as to the position of every constellation, with all its leading stars, in every quarter of the sky, for every month and practically every night in the year: and adapted not only to our own country, but to a corresponding and more extensive zone in North America also. This is a step in the right direction. It will not only offer material aid in removing the stigma of general ignorance, but prepare the youthful mind by familiar knowledge of what may be reached by the naked eye, for a more easy and unhesitating employment of the telescope in future years. Because we wish so well to Mr. Proctor's undertaking, we shall venture to point out some changes that, in our view at least, would be improvements. We can quite understand his desire of rendering his maps as full as possible; and his own eye would not be in the least embarrassed by that crowding of detail which we fear might perplex or even dishearten a beginner. But it would certainly be an advantage if there were more open space. The names of the constellations might be rendered less prominent, or abridged, or indicated by letters or symbols, and those of the principal stars might be transferred to the separate diagrams; much would be gained by an increase in the size of the stars, and greater clearness by the adoption of the easily-explained word "zenith" in place of "the point overhead." In matters of detail, a transposition may be pointed out in the diagram on p. 12; and the "sickle," on p. 90, and the "dumb-bell," on p. 176, require improvement. The text contains a great deal of interesting and amusing as well as instructive matter; but tastes may differ as to the desirableness of introducing so many remarks, however ingenious, on other ways of arranging stars in constellations, when the beginner may have enough to do in comprehending and recollecting them as they are, and will always remain. We are inclined to think that the name of the "Great Bear" is as common in England as the "Plough," and had better have been more frequently employed. On p. 108, γ and ϵ Cassiopeiæ stand instead of γ and δ, as pointers to the great cluster in the sword-hand of Perseus—described again, by the way, on p. 125—which most eyes, we believe, with Argelander and Heis, would see double. We have failed to find any notice in the text of the conspicuous nebula in Andromeda's girdle; and the Dumb-bell, invisible without a telescope, is not fortunately chosen as an instance of spectroscopic results, its light, according to Huggins, exhibiting only a single line. A little haste is probably traceable in these defects, which we hope the author may have an opportunity of rectifying.

OUR BOOK SHELF

Die Pflanze. Vorträge aus dem Gebiete der Botanik. Von Dr. Ferdinand Cohn. 8vo. pp. 512. (Breslau: Kern, 1881.)

THIS book may be placed by the side of Schleiden's "Die Pflanze und ihr Leben," which was published in 1847, and ran to at least six editions in German, besides being translated into English, French, and Dutch. The English edition was translated by Henfrey, and was published in 1848; and it soon became a popular book, as it dealt with various aspects of plant-life in language intelligible to every one, without any loss of scientific accuracy and without any mixture of fable and fiction.

Taking date for date, the present work does not suffer by comparison with its evident prototype; and, although there is no attempt to traverse the whole region of botany, this covers a much wider field. It is intended, as the author informs us in his preface, to be a guide to those who wish to participate in the intellectual life that pervades modern botany. Like Schleiden's work, it is based upon a number of lectures, delivered, in this case, in different parts of Germany during the last twenty years, and published in their original form in various journals. With few exceptions, however, they have been remodelled and revised, partly with the object of bringing the subjects therein treated up to the present state of knowledge, and partly with the object of eliminating repetitions and correcting inequalities of style. Each lecture is complete in itself, yet naturally a connecting thread runs through all. The opening lecture in the present arrangement, which is not a chronological one, is entitled "Botanical Problems" (noticed in NATURE, vol. xi. p. 261); and it appropriately takes precedence, because it is an historical sketch of the progress of botanical discovery. Altogether there are sixteen lectures bearing such descriptive titles as: "From the Pole to the Equator," "Life in a Drop of Water," "Invisible Foes in the Air," "Insectivorous Plants," "From the Sea Level to Eternal Snow," and so on. There is also one on Bacteria—of which organisms the author has made a special study; one on the Rose; one on the Grape Vine; and the last is on Ancient and Modern Gardens. Systematic botany, however, seems to be regarded by the writer as the particular branch to avoid teaching, for he has no lecture on the classification of plants. Perhaps he found it less easy to treat this in a popular style, or perhaps he fears that a knowledge of classification encourages the craze for collecting and learning the technical names of plants that is still far too prevalent? Anything that tends to discourage the mere collector is praiseworthy. Nevertheless, we think the principles of classification are at least of equal importance with the subjects treated. Yet in this case we are hardly justified in complaining because the author has not given more, especially as he has not promised to; and he has done so very well what he has done. There is no doubt that these lectures will be widely read, and they deserve to be, for they contain much interesting information, and they are written in an easy graceful style without superabundance of adornment. They are almost devoid of technical terms, and in all cases where they exist popular names are used in preference, though the Latin ones are given with other annotations at the end of each lecture. The book is well printed on good paper and embellished with some original and appropriate head and tail-pieces.

W. BOTTING HEMSLEY

La Lumière Électrique, son Histoire, sa Production, et son Emploi. Par Em. Alglave et J. Boulard. (Paris: Firmin-Didot et Cie., 1882.)

THE great success of the Electric Exhibition at Paris of 1881 has not failed to produce an effect upon the demand for books dealing with electrical science, and particularly with the practical applications of electricity. The wide extension of electric lighting, and the continued growth of popular interest in the subject are producing a perceptible effect also on the book market of this country. Text-books of electricity were never so greatly in demand as to-day, and we were recently informed that one of the

newest-published text-books of the science is being bought by the public at the rate of a thousand copies a month. Under these circumstances it would be remarkable if all the works put before the public were of equal scientific merit, for such a demand cannot but tempt into the field the semi-scientific bookmaker who is ever ready to produce something to meet a popular taste. The work before us must, we fear, be classed with the semi-scientific. Its authors, so far as we are aware, are gentlemen who have yet to make their mark in the scientific world, and who, though not ill-informed in a general kind of way as to the applications of the science, cannot be said to have added by their present work to the scientific knowledge of the subject. The work opens with an account of the history of lighting in general from the days of Greece and Rome; and it devotes no inconsiderable part of its pages to the early history of electric lighting. We observe, by the way, that the authors fall into the error of putting Davy's discovery of the voltaic arc so late as the year 1813, when he experimented with his large battery of 200 cells. But he had discovered the arc at least nine years before that date. The manufacture of carbons for electric light claims half a dozen pages. Not too much when there is so much dependent on the quality of the carbon, and when carbons are as bad as they are. But we were not aware that those of M. Napoli were so superior to all others as to deserve a monopoly of description. The process of covering the exterior of the carbon-rods with an electrodeposited coating of copper is stated by the authors to have been first adopted in 1875 by M. Reynier, whose semi-incandescent lamp and modified Daniell's battery are described in effusive detail, though neither of these inventions can be said to be of capital importance. The chief feature in the book is that part which deals with the various systems of electric incandescent lamps. These are described very fully and with copious illustrations. The authors appear to prefer the system of Edison, for whom they have a great admiration, of whom they give a portrait (an honour shared by M. Gramme only), and concerning whom they narrate very naïvely several gossipy tales—how he and his assistants were nearly poisoned by mercury vapour when they first tried to work Sprengel pumps, and how he sent an expedition south for the metal thorium. The section devoted to dynamo-electric machines is also well illustrated, and fairly descriptive, though the style of exposition is of the "popular" order. The work concludes with a notice of the application of electric light to lighthouses, to naval and military warfare, and to the stage. With respect to the first of these applications, the authors attribute to Fresnel the application of dioptric lenses to lighthouses. Is it ignorance, or is it patriotic bigotry that is to blame for their obliviousness of the fact that Brewster suggested this very application in 1812, ten years before Fresnel, and that in 1820 he had already taken steps to urge the matter upon the notice of a too deliberate officialism? Many excellent woodcuts adorn the pages of the work of MM. Alglave and Boulard, which will doubtless make it a welcome book for many a library table where popular science is in request.

An Elementary Treatise on the Tides based upon that of the Late Sir J. W. Lubbock, Bart., F.R.S.; to which is added a newly-devised Method of Computation of the Heights of High Water at Liverpool, with Factors for other Ports, and Tables adopted by the Admiralty. By James Pearson, M.A., F.R.A.S. (London: J. D. Potter; Fleetwood: W. Porter and Son, 1881.)

THIS Treatise on the Tides, by the Rev. J. Pearson, M.A., F.R.A.S., contains an interesting historical sketch of tidal theories, extending from an early period to the present time; and while referring to the slow progress made in our knowledge of tidal phenomena, assures the inquirer of the interest attending the investigation. The researches of Newton, Bernouilli, La Place, and others, had gradually established a theory which, from the discussion of many observations made at ports in the United Kingdom by Sir J. Lubbock, brought into practical use a series of tables by which the times and the heights of high water at certain places, mainly on the shores of the United Kingdom, could be computed with an accuracy sufficient for the requirements of seamen, and others interested, especially the proprietors of docks. Based on the general results of Sir J. Lubbock's labours, the author, from observations extending over several years, has introduced tables auxiliary to those heretofore employed, for computing the heights of high water at Liverpool, where the tides have occasionally the great range of thirty-three feet. The results of these predictions (as compared with observation) show that the course of the "diurnal inequality"—previously disregarded—has by their aid been successfully traced. On the coasts of Great Britain generally, the diurnal inequality is not so important a factor as it is at Liverpool, at which place it amounts at times to one foot or more. The treatise cannot fail to be received with interest and to encourage attention to the subject.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Movements of Jupiter's Atmosphere

The reference to the belts of Jupiter contained in my article on the geological activity of the tides (NATURE, vol. xxv. p. 213), was perhaps superfluous, for the subject is only collaterally connected with the points there under discussion; but as Mr. Mattieu Williams has commented on what I said, I should like to make a few remarks on his letter. Notwithstanding what he says I am still inclined to hold that the time-honoured explanation of the belts of Jupiter is the true one. In that explanation the terms trade and anti-trade winds are, I conceive, used in a somewhat extended sense as a consequence of thermal causes, and without reference to the existence of a solid nucleus, a current is supposed to set upwards in equatorial regions and then to spread out into higher latitudes; here the fluid has more moment of momentum than is adapted for the latitude in which it finds itself, and accordingly moves relatively to the subjacent matter in the direction of the planet's rotation, and forms an anti-trade wind. Conversely the trade winds arise from fluid moving into lower latitudes, when it has a deficiency of moment of momentum. Such an explanation seems to serve equally to explain the unequal rotation of the surface of the sun in different latitudes, and the Jovian belts.

The trade and anti-trade winds are essentially a thermodynamic effect, and in my paper I expressed an opinion that they might be partly due to the heat of the Jovian nucleus. It seems to be generally assumed that the great rapidity of that planet's rotation is a sufficient cause for the great violence of the supposed trade-winds which produce the belts. But my chief object in referring to the matter was because rapidity of rotation is not a sufficient explanation, without a statement as to the mode of reinforcement of the thermodynamic causes. Now the great distance of Jupiter from the sun largely weakens those causes, and it seems to me that there are only two ways in which they can be strengthened, viz. first by the large amount of gas on which the solar radiation has to work, and secondly, by the heat of the nucleus.

With regard to the deductions to be drawn from the low specific gravity of Jupiter, I may mention that in 1876 I pointed out that the observed ellipticity of the planet's figure can only be explained on the assumption of great density of the central portions of the planet. Taking indeed the best data attainable, I showed that the mean density of Jupiter must be about 70 times as great as the superficial density, if we follow Laplace

as to the nature of the law by which the density increases internally.[1] In the article in *Nature*, I adduced the argument on which Mr. Williams comments, as a slight corroboration of the conclusions as to the physical constitution of the planet, which have been derived from telescopic inspection, and from observation of the ellipticity of figure.

From the latter part of Mr. Williams's letter I must beg leave to dissent. If one were to describe the oceanic tides on the earth as a reeling motion of the solid earth within the sea, it would surely be a somewhat obscure description of the facts, but the reeling of the Jovian nucleus *can* only be a tidal phenomenon.[2] Now the masses of the Jovian satellites are so small, that they can only raise very small tides, except indeed on one hypothesis, of the truth of which we have no evidence, and which would not tend to explain the belts if it existed. The tide raised by a small satellite can only be large when the "free" period of oscillation of the gaseous or liquid ocean is nearly the same as the "forced" period. If this were the case with one of Jupiter's satellites, it certainly would not be so with the others. Although tides accompanied by *fluid friction* do tend to produce a longitudinal current adverse to the planetary rotation, yet no current of a millionth part of the velocity requisite for the production of the belts could possibly be occasioned by the tidal friction due to Jupiter's satellites.

For these reasons I quite dissent from Mr. Williams's explanation of the belts, and of the unequal solar rotation.

Sir William Thomson has recently pointed out, in a paper read before the Physical Society of Paris, a probable cause of the reinforcement of an atmospheric tide in the earth, due to an approximate agreement of free and forced periods of oscillation. He remarks that the semi-diurnal constituent of the barometric oscillation is nearly everywhere very much larger than was to be expected, and he shows that the sun and earth together constitute a thermodynamic engine whereby the earth's rotation is accelerated. Rough numerical calculations are given, wherefrom it appears that the amount of this acceleration may not be entirely negligeable, when we consider the degree of refinement to which modern astronomy has arrived. G. H. DARWIN

R.M.S.S. *Medway*, Southampton, Feb. 2

[1] Monthly Notices of R.A.S. Dec. 1876. "On an Oversight in the Mécanique Céleste, and on the Internal Densities of the Planets."

[2] The expression "reeling" would at the first glance lead one to suppose that a diurnal tide is referred to, in which the fluid parts are carried relatively to the nucleus in the direction of the disturbing satellite, but without change of superficial form, technically a spherical harmonic deformation of the first order. But it is well known that this class of displacement must be non-existent, and therefore it must be presumed that Mr. Williams does not intend this.

The Search for Coal under London

IN a recent communication to this journal I dwelt upon the importance of a systematic search being made for the Carboniferous rocks under London, by a series of borings running from north to south, and only a few miles apart; but I pointed out at the same time that much of the expenditure required for such a search might be saved by a judicious selection of sites for the first two or three borings. I then quoted the opinions of Mr. Godwin-Austen and Prof. Prestwich as to the localities at which such explorations might be undertaken with the greatest chance of success. My friend, Prof. Prestwich, has written to me expressing general agreement with the views I have put forward on the subject, but calling my attention to some other suggestions of his as to the points at which borings might be executed, with fair hopes of success. Writing in the Reports of the Coal Commission in 1870 (p. 162), Prof. Prestwich expressed himself as follows:—

"The direction of the great underground coal trough is, we think, likely to be on a line passing through North Wilts, Oxfordshire, thence across Hertfordshire, South Essex, the north-east extremity of Kent, onwards towards Calais, near to which place it is thrown out by the rise of the underlying rocks, but resumes again at Thérouanne. Or in case of the anticlinal axis taking a more southern course we should look for the coal basin or basins along a line passing from Radstock, through the Vale of Pewsey, and thence along the North Downs to Folkestone and near to Calais."

Some years later Prof. Prestwich wrote as follows:—

"In short, while there is every reason to hope that on the *south* of London we may yet find in the *Lower Greensand*, beneath the Tertiary Strata and Chalk, a source of large and valuable water-supply for metropolitan purposes, there is strong reason to believe in the probability of the discovery to the *north* of London of *Carboniferous Strata*, including possibly productive Coal-measures." . . . ("On the Range of the Lower Greensand and Palæozoic Rocks under London," by J. Prestwich. From *Quart. Journ. Geol. Soc.* for November, 1878, p. 911.)

The discovery of Upper Devonian strata, both at Turnford and at Tottenham Court Road, in both cases dipping at high angles, lends not a little support to the view that a trough of Carboniferous strata may exist between those two localities. Prof. Prestwich authorises me to state that what he would now recommend would be a boring "a mile or two north of Kentish Town, not directly north, but north-east or north-west, so as to avoid the hills—say about Edmonton on the one side, or near Edgware on the other." On the south side of London he would prefer to avoid the Lower Greensand, and would recommend a boring "just beyond its outcrop at Red Hill—somewhere between there and Horley." But he thinks that if Coal-measures were found to extend beneath the Lower Greensand, means might be found to sink through the latter, by the new appliances of which the Belgian engineers have so largely availed themselves. JOHN W. JUDD

Researches on Animals containing Chlorophyll

1. DR. BRANDT'S observations (*Sitz. d. Berlin Physiol. Gesellsch.*, Nov. 11, 1881) are upon the green bodies of *Hydra*, *Spongilla*, a fresh-water planarian, and numerous infusors. He finds that these green bodies are masses of hyaline protoplasm, containing a nucleus and a chlorophyll-granule. Sometimes two to six are present, these he considers are states of division. He regards these facts as proving that those bodies are unicellular algæ, and erects the genus *Zoochlorella*. He finds them survive isolation, and even develop starch in light. Specimens from Spongilla were taken in by infusors, but were either digested or ejected: those from a dead Hydra were, however, retained by *Paramæcium*, *Coleps*, &c. He believes that the chlorophyll never belongs to the animals, but always to algæ.

My observations deal with the yellow cells of quite different animals. I have, however, ventured the opinion that in most of the above cases, the green bodies do belong to the animals, and are not algæ, and I do not yet see sufficient reason for withdrawing that view.

2. For the yellow cells of Radiolarians and Cœlenterates (for the alga nature of which Dr. Brandt so ably argued in his former paper) he proposes the genus *Zooxanthella*. Here Dr. Brandt has doubtless priority.

3. He observes that large Radiolarian colonies show no signs of digesting foreign bodies, that these and also Spongilla can be kept best in filtered water, and that the latter will not live in a half darkened room. These facts are doubtless new.

4. Dr. Brandt concludes that the algæ maintain their hosts; that so long as the animals contain few or none, they feed in the ordinary way, but when sufficient algæ are present, they are nourished like plants. He indicates an analogy to lichens (an hypothesis which, as I also state in my paper, was first ventured by Semper), and yet points out a distinction, since in a lichen there is an association of an alga with a true parasite, here a "Symbiose" of algæ with animals accustomed to independent life, which they, however, give up, and take in no further nutriment. Thus in a morphological sense the algæ, in a physiological sense the animals are the parasites.

While welcoming Dr. Brandt's interesting paper, and while not desiring to lay too much stress on such awkward facts for his view as that *Hydra*, *Anthea*, *Velella*, &c., are quite as voracious as their congeners unprovided with chlorophyll, or that the animal may possess its chlorophyll from development, and while giving him and his predecessors all due credit for their valuable observations and theoretic insight, I must point out that (1) the *demonstration* of the truth of the view that the yellow cells of Radiolarians and Cœlenterates are algæ, (2) the development of the hypothesis of the lichenoid nature of the alliance between alga and animal into a theory of mutual interdependence, and (3) the transference of that view from the region of probable speculation into that of experimental science, remain with my paper. For it will not do to ignore, with Dr. Brandt, such weighty opposing evidence as (1) the recent direct statement of Hamann that the yellow cells of Cœlenterates are not algæ, but unicellular glands, (2) the observation of Krukenberg that *Anthea viridis* did not evolve oxygen, or (3) the failure of himself and others to prove the presence of cellulose and chlorophyll, or even to

confirm Haeckel's discovery of starch in Radiolarians; objections which rendered the whole matter so utterly dubious that no botanist had ever accepted it, although its importance, especially to disciples of Schwendener, is obviously great. Nor is my theory of reciprocal accommodation entitled to supersede that held by Cienkowski, and formerly by Brandt, of simple parasitism of the yellow bodies, until it has been proven (1) that animals containing algæ are actually successful beyond their fellows in the struggle for existence, (2) that the starch is rapidly consumed, and (3) that the algæ are of importance in the function of respiration, for which, again, it is necessary to show (*a*) the evolution of oxygen by the algæ, (*b*) the absorption of a large percentage by the animal, and (*c*) the displacement of the respiratory pigment by the algæ when the former is normally present.

Such being the points of Dr. Brandt's paper, and of my own as compared with it, Prof. Moseley will doubtless be the first to see that he has been mistaken in assuming, from his perusal of their abstracts, that the main points of the latter have been anticipated. I must, however, sincerely thank him for so courteously calling my attention to my ignorance of Dr. Brandt's interesting paper, which I regret having failed to review in its proper order, especially as I should then have avoided the employment of a new generic name.

It is perhaps scarcely necessary to add that although its publication has unfortunately been delayed, my paper, together with other new material, was forwarded from Naples on October 26 last to the medical faculty of this University, as trustees for the quinquennial Ellis physiology prize. PATRICK GEDDES

Botanical Laboratory, University of Edinburgh, February 11

MY friend Prof. Moseley's communication in NATURE, vol. xxv. p. 338, induces me to send you the following remarks on Mr. Patrick Geddes' interesting and important paper with the above title which appeared in NATURE, vol. xxv. p. 303, and which I should otherwise have deferred noticing until I could publish a fuller account of the whole subject.

As mentioned by Geddes, Cienkowski in 1871 clearly pointed out that the yellow cells in some Radiolaria were parasitic algæ (using this adjective in the sense of living within other animals or plants, or their tissues, *i.e.* taking up house-room). Geza Entz of Klausenburg, in 1876 (February) seems next to have called attention to the subject, but, as he mentions in the *Biologisches Centralblatt* for January 20, 1882, his paper being published in the Magyar tongue, has been hardly known or indeed accessible to the scientific world outside of his Fatherland. Touching on the views of Ehrenberg, Fred. Cohn and Stein, as to the nature of the green granules in Infusoria, Entz shows by a series of observations the chemical nature (by reagents) of some of these green bodies, and that some continue to live after the death of their hosts, growing and developing until their total evolution proved them to be forms of unicellular Algæ, such as Palmella, Glœocystis, &c., &c., and justified the suspicion that they were "independent organisms that had forced their way into and temporarily enjoyed the hospitality of their hosts." He also shows that colourless Infusoria supplied with Palmellaceous cells rapidly become infected. In a note added to the translation of his paper in the journal above quoted, Entz mentions his later discovery of "nuclei" in these cells, and very correctly reiterates that they are but stages in the evolution of Algæ, and not species in the ordinary acceptation of that word. In 1877 (February), in ignorance of Prof. Entz's paper, I published an account of a green alga living as a guest in the fronds of other algæ, and also described its minute spores entering into and growing within the structures of Epistylis and Vaginicola, even figuring some adult forms within the lorica of *V. crystallina* and throughout the frond of the bright red *Polysiphonia urceolata*, and I ventured to suggest that these observations might throw some light on the Lichen-gonidia question. In 1881 (November) K. Brandt read a paper giving the result of a series of observations on the symbiosis (*Zusammenleben*) of algæ and animals before the Physiological Society of Berlin, an abstract of which was published in the *Biologisches Centralblatt* (December 15, 1881). Lastly comes the valuable paper of Mr. P. Geddes, in which he to a large extent confirms the observations of the previous labourers in this field of research. It may not be out of place to this very short historical sketch to add that investigations in reference to the minute alga, referred by me to Cohn's genus Chlorochytrium, now for several years continued—have enabled me to add many fresh instances of its spores finding house room in the bodies of animals, and of their accommodating themselves to the various circumstances of their "surroundings," when small they are generally greenest, and often the function of assimilation seems carried on in them to that extent as apparently to check their function of development. These observations I look forward to publishing in the *Transactions* of the Royal Irish Academy, where my earlier memoir appeared.

I make no reference here to the occurrence of chlorophyll bodies in animals apparently quite independent of the presence of vegetable cells, as brought to our notice by the researches of Sorby, Lankester, Moseley, and others. This, I take it, is not Symbiosism. E. PERCEVAL WRIGHT

On an Experimental Form of Secondary Cell

THE following description of a lead secondary cell exhibits so beautifully the part performed by the coating of red oxide of lead covering the new-made plates of Faure's accumulators, in forming them and in afterwards charging and discharging them, that I have no doubt that a trial of its experimental construction will interest those of your readers by whom improvements of the Faure's cell, in respect of retentiveness and capacity, and especially of durability, are regarded as useful objects of search, and as an important desideratum.

About four ounces of No. 5 lead-shot, cleaned and amalgamated to brightness, are placed at the bottom of a 10-oz. glass cell or beaker, so as to cover it to a depth of about half an inch, a loop of stout and clean lead wire having already been laid there flat, with its long straight part reaching vertically up the inner side of the cell to serve as a terminal for a binding screw. The straight part of the wire is lacquered in the manner usual with instrument-makers (while hot) thickly with shell-lac varnish to protect it down to the point where it turns into a loop, from acid action. The counter-plate of the cell is a thin horizontal lead one, suspended about an inch over the surface of the shots below by a strip of sufficient breadth and strength projecting from it up the inner face of the cell, to be bent over the top edge, as a carrier, and there provided with a binding screw. Before introducing it, one or two ounces of powdered minium, or red-lead, are thrown into the dilute sulphuric acid of the cell, and by a little gentle stirring, followed by very quick subsidence, this powder spreads itself evenly over the shot. When the liquid is clear, the counter-plate is introduced and the cell is coupled up to two small Grove's cells in series, so as to make the shots its anode, by connecting them with the platinum extremity of the exciting battery.

The action of the dilute sulphuric acid upon the red lead when immersed in it, besides disengagement of a little heat, and of a little contaminating carbonic acid, is partly to separate and partly to convert it into a mixture of the binoxide of lead and white lead sulphate, the two forming together a sombre red-brown powder forming a protecting layer over the stratum of metallic shot. Hydrogen is given off on the counterplate, but no oxygen gas makes its appearance at the bottom of the cell as the action of the exciting current proceeds; the nascent activity of the strongly ozonised oxygen of the pair seems to be entirely spent in oxidising the lead-sulphate already existing, and in converting it into lead-binoxide. The whole of the red powder-layer in the mean time grows uniformly and very slowly darker, until in about half-an-hour its ruddy brown colour has been completely toned down and deepened into that of the dark puce-coloured lead binoxide.

At the same time a singular action is proceeding among the metallic shot. A sort of snow of white lead-sulphate is forming on their summits and falling off them by its weight, as if showered down upon them out of the murky mass above; and there is no doubt that the presence of the minium layer serves to produce, through the medium of the lead-sulphate already there, a true corrosion of the lead, mainly conducted, as it would seem, by the acid which the process of binoxidation displaces from the superjacent sulphate. Out of contact with the incumbent powder, the bright metallic surfaces of the shots are only slightly dimmed and tarnished with a thin film of white sulphate, and it is the most remarkable feature of the process that this white film and the white caps of sulphate formed upon the upper shots are not at all discoloured, whereas without the overlying red lead protection, the lead surfaces would be immediately sooted and beclouded over with a dark-brown coat of lead-binoxide.

The nascent energy of the oxygen is evidently suppressed, and it would seem that the current takes its way by preference

through the solid sulphate, which it oxidises and decomposes, to reach the lead, to the total exclusion of the liquid channel through which it ordinarily attacks it, although liquid contact may very possibly be needed with the sulphate at its oxidation point.

Another unexpected feature presented itself, which perfectly confirms this view. My current source being a hand-gramme machine, turned by a water-turbine, which permits easy regulation of the current strength and tension by adjusting the water-tap, it was kept low at first, le t the discharge of oxygen-bubbles from the lead shot should project upwards some of the settled powder into the liquid, and disturb its clearness. But no such ill effects having occurred while the current's strength was cautiously increased during the first half hour, it was then finally raised to the full charging power of the turbine, taking up a wheel-speed, and tension of the current showing a slightly greater resistance in the cell than one of the same size made with rolled up plates would have offered to the machine-current. With this full tension of two or three Grove's cells, bubbles of oxygen soon formed round the shots, but instead of this gas escaping turbulently through the powder, it collected under it until of sufficient volume to find an intermittent passage round it at one corner of the cell, and through an accidental hole or crevice in the middle of the layer, without producing the least turbidity in the cell's quite recently deposited contents! The layer's uneven surface was also not at all disturbed by a little agitation of the cell, showing that it had acquired considerable consistency by the action of the charging current. Of this effect of the treatment, the passage of a current into and through the sulphate of the layer, during its process of oxidation, would, it seems probable, be a sufficient explanation. No return-current could at this stage be extracted from the cell, which is also the case at the outset in forming, by a constantly directed exciting current, a Faure's accumulator. The charging-current was therefore left running for the night, the shot-layer having well imbued itself in a froth of white particles under the dark roof above. The effect of current-reversal was, however, first tested, with the result, after a short duration, of dissipating the white sediment, and exposing again the bright surfaces of the amalgamated shot, while the counter-plate above acquired as usual, under such conditions, a thick Planté's coating of dark oxide. This was discharged, as may always be done when it makes its appearance, as a secondary current of some strength ringing a call-bell for no inconsiderable portion of a minute. The shots remained bright, and exhibited no visible alteration. The charging-current was reinstated, and they soon covered themselves again with the mantle of white froth and powder as described.

On the following morning a great transformation had occurred. Only a few specks of white sulphate remained undecomposed in the corners of the cell; the rest had all blackened, nearly hiding the shots, and separated by no definite line of demarcation from the now clod-like layer of what had been the minium-coat above. The latter really resembled grey and black earth-clods mixed together, the black or dark humus brown ones forming continuous extensions of the similar converted sulphate underneath, and the grey admixture being apparently the originally separated binoxide of the minium layer placed in the cell at starting. A secondary, or return current was obtained from the cell in this condition, which rang a call-bell strongly for seven minutes. No visible alteration of colour or other change of appearance in the materials furnishing this current at the bottom of the cell could be perceived while it was being extracted from them.

The charging-current was then applied again, and remained in constant action (during which time it was not visited) for twenty-four hours. On this second morning the blackening was so complete, that not only were the shots hidden, but the nether line of the top coat of minium was no longer distinguishable. The dark humus-like transformation of the sulphate enveloped the former, and penetrated the latter, leaving only some large insular grains and clods of the grey substance of the upper layer still unaffected, as if untraversed by the current's charging or compacting action. The duration, however, of the secondary current now yielded by the cell was still only seven minutes, as before; and no increase of storage capacity was therefore given to it by this long additional, and to all appearance strongly operative period of oxidising direct excitation. The materials as before underwent no visible change of aspect during the extraction of the secondary current.

The cell, evidently quite formed, was now once more filled to test its retentiveness. After a few hours of charging, the rough dendrites of humus-coloured substance acquired frond-like form and much greater compactness as they shrank asunder and approached apparently the ceramic and brittle state of consolidation which the coating of the Faure accumulator plates exhibits when they have been once or twice recharged. The shot-cell proved perfectly retentive of its charge, and although only a poor substitute for one of folded or rolled up plates, in storage capacity and in freedom from resistance it is yet a very fairly efficient accumulator. From the simplicity of its construction, and from the easy inspection which it permits of the several stages of the process of red-lead primary excitation, I can commend its use to those who are busily engaged, like myself, in the difficult and complicated study of the question of secondary battery improvements.

The tendency to cohere and harden which binoxide of lead possesses when formed by and submitted to a current, is well proved by the iridescent hues which it exhibits when deposited in the form of Nobili's rings on some bright metals, such as clean platinum and german silver, the optical explanation of which points to the existence of a good reflecting surface in the film. A similar reflecting surface is found to exist, for oblique incidences of light, in the opaque layer of soot of a candle-flame on smoked glass; and it may be that this optical character of such deposits which cannot be perceived by the microscope to be granular, is not physically unconnected with the electrical properties of the film which, in the case of binoxide of lead, give it capacity for storage in the chemical form of the energy of the secondary current. And yet it is not only by enlarging the area of the coherent binoxide film, and extending the surface of lead over which it is spread, that increase of storage capacity can be given to corrugated or to spongily and otherwise roughened lead elements; but it appears also to be attainable, at least in some degree by increasing the thickness of the film; for on reversing the exciting current of the lead-shot cell, for the second time only, so as to oxidise the counter-plate, the secondary or return current taken from this plate rang the call-bell continuously for twenty minutes, which denoted a storage capacity in the little exposed surface of the small lead-plate nearly three times as large as any before arrived at in the thick layer of shots at the bottom of the cell. A. S. HERSCHEL

College of Science, Newcastle-on-Tyne, January 28

P.S.—It appears to be the hydrogen occluded in the positive plate as much as the oxygen stored up on the negative one that gives the Planté and the Faure cells their secondary voltaic power; for on trying several metals as the positive plate in the shot-cell, after charging it again directly to its full capacity, I found their order as regards the strength of the secondary, or return current obtainable with them from the charged cell to be as follows:—

Clean lead: a feeble current, only traceable with a galvanometer. Amalgamated lead gave the same.

Copper: a pretty strong current, which easily rings the call-bell.

Hydrogenised lead (the counterplate used in charging the cell directly): a strong current, ringing the bell loudly, and giving a spark between its wires.

Hydrogenised platinum (prepared like the last lead plate): at first a strong current like the last, but degrading gradually, and not inferior in duration or storage capacity to that of the last lead-plate!

Amalgamated zinc: a very powerful current, far exceeding the preceding ones, and capable of maintaining the motion of the Gramme machine and water-wheel when the water was turned off, which only a well-made Faure cell of twenty-five square-inch plates rolled together had enabled me to accomplish before. Yet the area of the zinc strip used as a counterplate in this cell was scarcely so much as two square inches!

It is, no doubt, to the insignificance of the clean-lead current and to the consequent practical suppression of local currents on the negatively-charged plate, that lead secondary cells owe their astonishing retentiveness. It also deserves attention that, from the proof of these experiments, a provision for fixation of hydrogen on the positive plate of lead cells must be made, equal in storage capacity to that which the binoxide furnishes for oxygen on the other plate. Both lead and platinum, it seems however, are equally capable of furnishing this lodgment for hydrogen without any special preparation by a previous conversion to the spongy state.

M. Antoine Breguet's Appropriations

ON looking through the recent *brochure* on the Gramme machine by M. Antoine Breguet, I observe that the author has appropriated, without acknowledgment, a large number of the beautifully executed Magnetic Figures which Prof. Silvanus Thompson has long since published, both in your columns (November 28, 1878) and elsewhere. So far as the eye can judge, M. Breguet's illustrations are printed from *clichés* of the very blocks used in Prof. Thompson's papers. If—as I understand was the case—M. Breguet's attention was called to the omission when he employed a similar illustration in a paper of his, which appeared some little time ago in the *Ann. de Chimie et de Physique*, the present oversight ought not to pass without some protest—the more emphatic as some of Prof. Thompson's figures are entirely new and of much theoretical and practical importance. W. F. BARRETT

Royal College of Science, February 4

On the Clenching of the Hands from Emotional and other Causes in the Two Sexes

I SHOULD like to invite the attention of readers of this paper to the above subject when they have the opportunity of making personal observations, believing myself to have noticed a curious distinction The number of my own cases, though sufficient to warrant me in broaching the topic, is not large enough to enable me to form definite conclusions. Whether the clenching of the hand be the result of mental emotion, of hysteria, or other nervous convulsion, of acute poisoning or of tetanus, women always seem to lay the thumb across the palm and fold the fingers over it, frequently wounding the skin of the ball of the thumb by the pressure of the index and middle finger-nails; while men invariably flex the fingers acutely first, now and then digging all four nails into the palm, and turn the thumb outside, across the back of the middle phalanges. About four years ago I witnessed a case of idiopathic tetanus in a black woman in Barbados; the disease had reached that advanced stage where the muscles of the extremities begin to be affected during the paroxysms, and it was interesting to observe, before actual clenching ensued, that the *thumb* first began to twitch inwardly, while the fingers were motionless. Possibly, this may be the unconscious result of habits acquired during life; I have had no opportunity of noting the phenomenon in children. Perhaps those who read this in the tropics, where there is usually plenty of tetanus, hydrophobia, and other convulsive maladies, will kindly communicate their experience. ARTHUR STRADLING

Parhelia in the Mediterranean—The Weather in Switzerland

THE parhelia of January 27, which Mr. Ch. H. Allen in Mentone describes, has also been observed at several places in Switzerland: for instance, at Glaris and at Basle. The phenomenon has here been more completely developed; the sun appeared surrounded by two lightly-coloured halos of 46° and 92° in diameter. Owing to the sun's low altitude, little more than the semi-circumference of them was visible. Each of these halos had on its summit a tangent arc, turning its convexity toward the sun, the arc on the greater circle shining, as usual, in brilliant colours. On the inner halo, in the same altitude with the sun, two mock suns of a reddish tint were seen; a third appeared at the summit of the same circle at the junction with the tangent arc. All circles turned their red side to the sun. That part of the sky was covered with faint cirrus. The spectacle lasted from 2 to 4 p.m. In the evening of the 27th and also of the 29th the common halo of 46° diameter was seen round the moon. During the night of the 30th to the 31st some snow fell (melted 2·8 mm. in the rain-gauge), the first in this year.

On January 29, at 3.2 p.m., a brilliant meteor with a bluish trail was observed falling in a south-easterly direction; it vanished about 15° above the horizon. The same meteor was noticed at Scanfs in the Engadine, where a heavy detonation was heard.

The Basle section of the S.A.C. ascended Mount Pilate, near Lucerne, on January 28. The extreme transparency of the air afforded a view more splendid than is to be seen in summer. The minutest details of the Jura, and of the Black Forest and the hills of the Hohgan near the Lake of Constance, could be perceived; only the Vosges Mountains were a little dimmed. An ocean-like fog spread over the low parts of the country at a level of about 650 m. above sea. On the summit of Mount Pilate the thermometer marked −4° C. (25° F.) during the night, and +1° C. (34° F.) before sunrise. Over the surface of the Lake of Lucerne the air temperature was, at noon of the 29th, −2°·5 C. (27°·5 F.); above the fog an hour before, +4° C. (39° F.). ALBERT RIGGENBACH

Basle, February 11

On the Climate of North Northumberland as Regards its Fitness for Astronomical Observations

I HAVE looked again at my observations (p. 317), and can assure Mr. Joseph Lingwood of their entire accuracy. For astronomical purposes the sky is "completely overcast" when not a star is visible. As the observations in question referred to the year 1881, I do not see what the "weather since taken" has to do with the question, unless it be contended that the weather in January, 1881, was precisely similar to the weather in January of the present year. As a general rule the observations would refer to a later hour than 6 p.m.

JEVON J. MUSCHAMP PERRY

S. Paul's Vicarage, Alnwick, February 13

Jago's "Inorganic Chemistry"

THE kind tone of the first part of the notice, in your issue of December 15 (vol. xxv. p. 150), of my work on Inorganic Chemistry leads me, with your permission, to reply to some questions asked by the reviewer in the latter portion of his remarks. He first inquires "Why should he (the student) begin his chemical career by learning that 'combining weight' is synonymous with 'atomic weight'?" To this I answer, Because in our best standard works on chemistry these terms are applied indifferently to the same series of numbers; and further that the combining weight, a number deduced from experiment, is according to the atomic theory the relative weight of the atom of that particular element. To the query "Why should he draw from the statement of Avogadro's law the *erroneous* conclusion that the molecules of all gases are of the same size?" I reply by pointing out that Frankland states that the bulk of any elementary molecule, in the gaseous condition, is the same as that of hydrogen; and that Roscoe, Miller, and Tilden affirm that all gaseous molecules occupy the same volume. The phrase "are of the same size" is simply intended to convey, the same meaning as the term "occupy the same volume." I have not deemed it necessary in such a work as that under review to point out that the volume occupied by a molecule consists in part of intermolecular space; neither do the works of the chemists quoted when explaining the same law.

My own experience of teaching chemistry has convinced me that a knowledge of the "atomicity" of the most important elements is a vast help to even young students, as thereby they learn to write formulæ and equations not merely from memory, but in accordance with certain definite rules. The value of graphic formulæ is considerable, and with sufficient space at my disposal I should be quite prepared to demonstrate that the formula referred to of nitrous oxide does afford a reasonable hypothesis of the molecular constitution of that compound. Although I hold these opinions I have however carefully pointed out (p. 106) that the so called laws of atomicity are not always obeyed, and have dealt at some length with the notable exception, nitric oxide NO.

I regret to thus trespass on your valuable space, but in justice to myself and the work thus reviewed I ask you to kindly insert this letter. WILLIAM JAGO

School of Science and Art, Brighton

["Combining weight" is not synonymous with "atomic weight," *e.g.* 4·6 parts by weight of nitrogen combine with 1 part by weight of hydrogen, but the atom of nitrogen is 14 times heavier than the atom of hydrogen; 8 parts by weight of oxygen combine with 1 part by weight of hydrogen, but the atomic weight of oxygen is 16, that of hydrogen being 1. In some cases, *e.g.* chlorine, the combining and atomic weights are represented by the same number. I admit that the terms in question are applied to the same series of numbers, in many standard books on chemistry, but I maintain that they are applied erroneously.

I cannot admit that because "equal volumes of gases contain equal numbers of molecules" therefore "all gaseous molecules

occupy the same volume." From experiments on friction of gases, velocity of gaseous diffusion, &c., conclusions have been drawn as to the sizes of different molecules; Avogadro's law, however, says nothing as to the relative dimensions of molecules: the conclusion drawn by the author from Avogadro's law is therefore I think rightly called an "erroneous" conclusion, apart from any considerations as to the accuracy of the statement, "the molecules of all gases are of the same size."

A knowledge of the "atomicity" of the most important elements would, I admit, be of much importance. But when the evidence on which this or that value is assigned to the "atomicity" of these elements is examined, it is found in most cases to be very slight: a great structure has been raised on a shifting foundation. A student who has committed to memory the assertion that the "atomicity" of the nitrogen atom is five is probably ready to receive with gratitude the formula for nitrous oxide referred to; had he asked for the evidence on which the assertion as to the atomicity of nitrogen rests, and for an explanation of the assertion itself, he would I think hesitate before accepting the graphic formula in question as in any way affording "accurate and well-grounded information."—THE WRITER OF THE NOTICE.]

The Recent Weather

REFERRING to the leading article on "The Recent Weather" in a former number, perhaps the following proverb, prevailing I think in Norfolk, may possess some interest:—

"When Martinmas ice will bear a duck,
The winter will all be mire and muck."

Martinmas Day is on November 11. Bearing in mind that Martinmas, like Christmas, connotes a season rather than a particular day, and still more, that cold weather would usually come earlier in Scotland than in the eastern counties, the proverb seems to be entirely in unison with Sir Robert Christison's prognostic. CHARLES J. TAYLOR

Toppesfield Rectory, Halstead, Essex

FATHER LOBO'S "ABYSSINIA."—A correspondent asks if there is any trustworthy evidence that Lobo's "History of Abyssinia" was ever published in Portuguese, as stated in most biographies. The extracts translated by Sir Peter Wyche and published by the Royal Society in the end of the seventeenth century, were made from the manuscripts, as was also Legrand's translation in the beginning of the eighteenth, from which Dr. Johnson made his epitome. In Barbosa-Machado's "Bibliotheca Lusitana" there is no mention of a Portuguese edition.

ON THE WHALE FISHERY OF THE BASQUE PROVINCES OF SPAIN [1]

MY attention was drawn to the Basque Whale-Fishery by observing, during my study of Arctic literature, and especially while editing the voyages of William Baffin, that the first English whaling vessels were in the habit of shipping a boat's crew of Basques to harpoon the whales. I was informed that a whale, the *Balæna biscayensis*, had frequented the coasts of the Basques provinces from time immemorial; but that it had become nearly extinct in the seventeenth century, when the Basques began to extend their voyages further north, and across the Arctic Circle. Hence the Basques had become dexterous whale-fishers long before any other European people had entered upon that perilous occupation.

I found that several naturalists had investigated the history of the Biscayan whale, notably Eschricht and Reinhardt in Denmark, M. Fischer in France, and Prof. Flower in this country. Full information respecting these investigations is contained in Eschricht and Reinhardt's memoir, published by the Ray Society in 1866; and many interesting particulars have since been brought to light respecting the whale-fishery so far as it relates to the French Basques, and to the ports of Bayonne, Biarritz, Guétary, St. Jean de Luz, and Ciboure. But in looking through the books and papers on the subject, a list of which was kindly furnished to me by Prof. Flower last June, I did not find any particulars respecting the Spanish ports, where the Basque sailors are more numerous than in France, and inhabit a more extensive line of coast. I therefore thought it possible that, by visiting those ports and making inquiries respecting the literature of the provinces in which they are situated, and the local traditions, I might be able to collect some further information touching the whale-fishery of the Basques. It has now been suggested to me that such particulars as I have succeeded in bringing together, from their bearing on the history of the *Balæna biscayensis*, a nearly extinct animal, would be interesting to the Zoological Society. I therefore have pleasure in communicating the following notes on the subject.

The coast which I personally visited this summer extends from the French frontier to the Cabo de Peñas, including the Basque provinces of Guipuzcoa and Vizcaya, and the purely Spanish provinces of Santander and the Asturias. It is for the most part bold and rocky, with lofty cliffs of cretaceous limestone, having strata hove up at great angles. Occasionally there is a stretch of sand, generally at the mouths of rivers, and here and there a rocky little boat-harbour. Forests of oak and chestnut clothe the mountains, with occasionally open spaces of fern and heather and bushes of arbutus and myrtle. In some places the chestnut-groves come down almost to the water's edge. Along this coast there are many small fishing-towns. Fuenterrabia, on its picturesque hill, overlooks the French frontier. Following the coast to the westward the next port is Pasajés, and then comes the city of San Sebastian, which was the centre of the old whale-fishery. Zarauz is a town stretching along the shores of a sandy bay. Guetaria is built in a cleft of rocks which are sheltered behind the island of San Anton. Zumaya and Deva are are at the mouths of rivers; and Motrico is a picturesque little town built on steep slopes like Clovelly, overlooking a rocky bay. These are the ports of Guipuzcoa.

Ondarroa, at the mouth of its river, where small schooners are still built, is the first port of Vizcaya, coming from the east. Lequeitio is a large and more important place, sending out about a hundred fishing-boats. Next come Mundaca, at the mouth of the river of Guernica, Bermeo, another populous fishing-town with as many boats as Lequeitio, Plencia, and Portugalete and Santurce in the bay of Bilbao. These are the principal Vizcayan ports. The province of Santander has Castro-Urdiales, Laredo and Santoña on the shores of a large harbour, Santander itself, and San Vicente de la Barquera. In the Asturias are the ancient ports of Llanes, Rivadesella, Villaviciosa, the important town of Gijon, Candas, and Luanco. From the little village of Luanco to the end of the Cabo de las Peñas is a walk of eight miles, and this was the most western point I reached.

The Basque fishermen are a handsome race. They go away on their fishing-voyages for many days, and are brave honest, and industrious; while both men and women are always cheerful and light-hearted. They belong to a people who, for centuries, have repelled foreign invasion, have enjoyed free institutions, and made their own laws. The Basque fishermen are the descendants of the old whalers, and retain their traditions. They have, from time to time, produced naval worthies whose names are historical. Among them are Sebastian del Cano, a native of the little fishing-town of Guetaria, who was the first circumnavigator of the globe; Legaspi, the conqueror of the Philippine Islands; Machin de Munguia, the Spanish Grenville; and Churruca, whose gallantry at the battle of Trafalgar won for him the admiration of his English foes.

Such men were the product of the whale-fishery, which was for the Basques, as it has since been for the British, an admirable nursery for seamen.

My first inquiries had reference to the antiquity of the

[1] By Clements R. Markham, C.B., F.R.S. Read at the Zoological Society, December 13. Revised by the Author.

Basque whale-fishery. The following facts show that it was a well established trade in the twelfth century, so that it probably existed at least two centuries earlier. King Sancho (the Wise) of Navarre granted privileges to the city of San Sebastian in the year 1150 A.D. In this grant there is a list of articles of merchandise with the duties that must be paid for warehousing them: whale-bone has a prominent place in the list. "*Carga de boquinas-barbas de ballenas . . . . 2 dineros.*" The same privileges were extended by Alfonso VIII. of Castille to Fuenterrabia in 1203, and to Motrico and Guetaria in 1204. Ferdinand III., in a royal order dated at Burgos the 28th September, 1237, gave similar privileges to Zarauz; and this document contains further proof of the antiquity of the whale-fishery. For a claim is made that, in accordance with custom ("sicut forum est") the King should have a slice of each whale, along the backbone, from the head to the tail. The custom here referred to indicates the antiquity of the fishery. At Guetaria it was the custom to give the first fish of the season to the King, who usually returned half.

Another proof of the importance of the whale-fishery on the northern coast of Spain, and probably also of its antiquity, is the fact that no less than six of the towns have a whale for their coat of arms. This charge is in the arms of Fuenterrabia. Over the portal of the first house in a steep old street of Guetaria there is a shield of arms consisting of a whale amidst waves of the sea. At Motrico the town arms consist of a whale in the sea, harpooned, and a boat with men holding the line. The same device is carved on the wall of the Town Hall of Lequeitio. The arms of Bermeo and Castro-Urdiales also contain a whale. I was assured that *vigias* or look-out posts were established on the headlands, and high up the mountains overlooking the fishing-towns, whence notice was given directly a whale was seen spouting in the offing; and soon the boats were in pursuit. On the mountain of Talaya-mendi ("Look-out mountain") above Zarauz, there are some ruined walls which, according to Madoz, are the remains of one of these watch-towers, whence warnings were sent down the moment a whale was in sight. In some of the towns there are records which throw light on the whale-fishery, but (chiefly during the French occupation) most of the ancient archives have been destroyed or are lost. Fortunately this is not universally the case. In the town of Lequeitio eight of the "*libros de fabrica*" or fabric rolls of the church, commencing from the year 1510, have been preserved, which contain much interesting information.

The most ancient document relating to whales in the Lequeitio archives is dated September 11th, 1381. It is there ordered and agreed by the *Cabildo* that the whalebone taken shall be divided into three parts, two for repairing the boat-harbour, and the third for the fabric of the church. The same order is repeated in another document dated 1608. In the *Libros de fabrica de la iglesia de Lequeitio* there is a list of the whale killed, in various years, by the boats of Lequeitio, from 1517 to 1661.

1517. Two whales killed. 1525. Returns in money value. 1531. January and February, two large and one small whale killed. 1532. None killed. 1536. Two large whales and one small. 1538. Six whales killed. 1542. Two whales killed. 1543. One whale wounded by the Lequeitio people, but captured at Motrico. Divided between the two towns. 1543. Two whales killed, mother and young. The Mayor-domo working all day at the whalebone, and received 2 rials. 1546. February 24, a whale killed in front of St. Nicholas Island. The bone yielded 9½ ducados. 1550. Two whales killed. 1570. One whale killed. 1576. One whale killed. 1578. One whale killed. 1580. Three and a young one. 1608. One whale killed. 1609. Three whales killed. 1611. Two small whales killed, in concert with the men of Andarroa, which led to a law-suit. 1617. One whale killed. 1618. One whale killed. 1619. One whale killed. 1622 One whale killed with its young. 1649. Two whales killed. 1650. Two whales killed. 1657. Two whales killed and two young. 1661. One whale killed.

In the *Libro de Fabrica* including the years from 1731 to 1781 there is no mention of a whale, nor in the two succeeding books. The sailors went long voyages in search of them. But in 1712, fifty years after the last entry in the books, there were boats and apparatus for catching whales. In 1740 it was said that there were no sailors in Lequeitio, all having gone on long whaling voyages. In a record of a marriage at Lequeitio on July 15th, 1712, among the goods of the bride are mentioned a whale-boat with sails, lines, harpoons, and apparatus complete. Of the bridegroom it is said that "he was clothed decently, having four coats of London cloth, a good chest to keep his clothes in and another for travelling, a mattras, pillow, and blanket, and needful clothes for going to sea." So that between them they were well prepared for a whaling expedition.

These entries at Lequeitio indicate that, during the sixteenth century, the whales were abundant; for if this was the catch of only one village out of at least twenty along the coast, we may fairly multiply it by at least ten for the average yield of the fishery.

In the books of the *Cofradia de Marcantes* of Zarauz there are similar records, from which it appears that between the years 1637 and 1801 as many as fifty-five whales were killed by the Zarauz people, whose prowess was known throughout the Cantabrian coast. There is one noteworthy tradition at Zarauz, to the effect that two young sailors, without any help, chased, harpooned, and killed a large whale, and brought it safely to the beach. This deed is immortalised on imperishable stone. Over the portal of a house in Zarauz, No. 13 Calle de Azara, there is an inscription, now in the greater part rendered illegible by time, but with letters of the shape and style used in the sixteenth century. To the left of the inscription there is carved a harpooned whale, with the line fastened to a boat, in which are two men. Don Nicolas de Soraluce, the learned historian of Guipuzcoa, told me that an old resident in Zarauz, named Belaunzarán, had often spoken to him of the feat recorded on this stone slab; adding that he used to hear his grandmother explain that the carving represented the harpooning and killing of a whale by two young sailors in a single boat. This deed was considered worthy of being handed down to posterity, and the stone was therefore placed over the door of the house of these two brothers, or, as some say, a father and son.

There are some other records as to the disposition of the whalebone. By an order dated November 20th, 1474, the town of Guetaria gave half the value of each whale towards the repair of the church and of the boat-harbour. In San Sebastian, according to an ancient custom, the whalebone was given to the *Cofradia* (brotherhood) *of San Pedro*.

It is clear that the whales, close along the coast, became very scarce in the middle of the seventeenth century, when the entries at Lequeitio cease, and that the Basque sailors then began to seek the means of exercising their special craft by making long voyages, even to the Arctic regions. Such voyages were occasionally made at a still earlier period. It is stated by Madoz that a pilot of Zarauz, named Matias de Echeveste, was the first Spaniard who visited the banks of Newfoundland; and, according to a memoir written by his son, that he made twenty-eight voyages from 1545 to 1599, the year of his death. In the accounts of the first English whaling voyages to Spitzbergen, in the collection of Purchas, we read of Basque ships from San Sebastian frequenting those Arctic seas in search of whales, and of the overbearing way in which their captains were often treated by the English. Nevertheless, the English were glad to

obtain the help of the Basque sailors to do for them the most perilous and difficult part of the work, namely, the harpooning and killing of the whales.

I gather from Eschricht and Reinhardt's memoir, that this Biscayan whale was known to the French Basques as the *Sarde*, and was the same as the *Nordkaper* of the Dutch and North Germans, and the *Sletbag* of Iceland, a whalebone whale, but smaller and more active than the great Greenland whale. The *Konge-speil* (an ancient Norwegian record) has a passage to the effect that "those who travel on the sea fear it much, for its nature is to play much with vessels." Belonging to the temperate North Atlantic, it is described as much more active than the Greenland whale, much quicker and more violent in its movements, more difficult and dangerous to catch. It is smaller and has less blubber than the *Mysticetus*, the head shorter, and the whalebone much thicker, but scarcely more than half as long.

For centuries the Basques had attacked and captured this formidable Cetacean; and they, in fact, monopolised all the experience and skill which then existed in connection with the craft and mystery of whale-fishing. To the sailors of all other nations it was an unknown business, appearing all the more perilous from their absence of knowledge. So it was natural that the hardy and intrepid fishermen from the Cantabrian coast should be in requisition as harpooneers, as soon as the English and Dutch entered upon the Arctic whale-fishery, early in the seventeenth century. With their services, we also borrowed their words. Harpoon is derived from the Basque word *Arpoi*, the root being *ar*, "to take quickly." The Basque *Harpoinari* is a "harpooneer."

There is a letter still extant at Alcala de Henares, from James I. of England to the king of Spain, dated 1612, in which permission is asked to engage the services, on board English vessels engaged in the Arctic whaling-trade, of Basque sailors skilled in the use of the harpoon. The fact that Basque boats' crews were frequently shipped seems to show that this request was granted. In the whaling fleet fitted out for Spitzbergen in 1613, under the command of Benjamin Joseph, with Baffin on board the general's ship as pilot, twenty-four Basques were shipped. Orders were given that "they were to be used very kindly and friendly, being strangers and leaving their own country to do us service." The English seem to have adopted the fishing rules of the Basques, as well as to have benefited by their skill and prowess. Thus we read of an order being given because "the order of the Biscaines is that whoso doth strike the first harping-iron into him, it is his whale, if his iron hold." The Basques went out to attack the whales in the offing, while the English got ready for boiling-down. We read:—"News was brought to us this morning that the Basks had killed a whale; therefore we hasted to set up our furnaces and coppers, and presently began work; which we continued, without any want of whales, till our voyage was made"—thanks to the Basques. In another place Baffin calls the Basques "our whale strikers." Of course the English, in due time, learnt to strike the whales themselves; but the Basques were their instructors; and it is therefore to this noble race that we owe the foundation of our whaling trade.

In travelling along the coast, I found a universal tradition of the whale-fishery; and often the families of fishermen had the harpoons hanging in their houses, which had been there for generations. They still have occasion to use them when porpoises come within range; and on board one of the Gijon steamers there was a man with unerring aim. But many harpoons hang on the walls as relics of the old whaling days. At Laredo the fishermen brought me a harpoon of peculiar construction. The point was narrow and very slightly barbed, but there was a hinge half-way up the point, which was kept in line with the shaft by a ring. When the harpoon entered a whale, the ring slipped, the hinge turned, and the point came at right angles to the shaft, making it impossible for the harpoon to come out again. Baron Nordenskiöld informs me that this kind of harpoon is used by the Norwegians to kill the white whales.

At Llanes, in Asturias, I found a large palatial house which was formerly the "*Casa de Ballenas*," or house where business connected with the whale fishery was transacted. At Gijon there is also a "*Casa de Ballenas*," and also a street called Whale-lane. These names, with the coats of arms and traditions, are all relics of the old whaling days. At San Sebastian, too, there are enormous *tinajas*, or earthenware jars, in which the oil was stored.

It was at one time supposed that the *Balæna biscayensis* had become quite extinct; but this is certainly not the case. Whales are seen on the Cantabrian coast at intervals of about ten years. In 1844 a whale was seen off Zarauz. Boats went out and it was hit, but it broke the lines, and got away with two harpoons and three lances in its body, after having towed the boats for six hours. On the 25th of July, 1850, early in the morning, a whale appeared off Guetaria. Boats quickly pursued it, but the harpooneer missed his aim, and the whale went off, heading N.W. In January 1854 a whale and her two young entered the bay of San Sebastian. One of the young whales was singled out for attack, but the mother made desperate efforts to defend it, and once broke the line. Eventually the mother and one calf escaped, while the other was secured. Of course, with proper boats and apparatus, and if the fishermen had had a little of their ancestors' experience, all three would have been caught. It is the skeleton of this young whale that Professor Eschricht purchased at Pampluna. It is now at Copenhagen.

While I was at Gijon, in the Asturias, I was told by an old fisherman that a whale had been caught, about twenty years ago, by the villagers near the lighthouse on Punta de Peñas. The story was not believed by merchants and others of whom I made inquiries, so I thought it best to investigate the matter myself. I, therefore, went westward to the little fishing-village of Luanco, and next day proceeded on foot across a wild mountainous country to the lighthouse of Punta de Peñas; a distance of sixteen miles there and back. There, in the court-yard of the lighthouse, was a whale's jaw-bone, and the man in charge corroborated the story. But he added the curious statement that the whale was dead and half flensed, drifting in under the land, when the villagers first saw it, and went out in their boats to tow it on shore. I also found parts of the rib-bones in the granary of a farm-house at Viodo, a hamlet near the lighthouse.

The last whale of which I obtained intelligence was sighted between Guetaria and Zarauz on the 11th of February, 1878. Many boats went out from these two places, and one boat from Orio. The first harpoon that kept fast was thrown by a smart young sailor of Guetaria, the countryman of Sebastian del Cano, the first circumnavigator of the globe. He is now in the Spanish navy. Eventually the whale was killed and towed on shore. No one derived any benefit, because there was a law-suit tried at Azpeitia. It appears that the harpoon was of Guetaria, but that the line belonged to Zarauz. Meanwhile the whale became unpleasant and had to be blown up. The authorities of San Sebastian, however, through the intervention of Don Nicolas Soraluce, secured the bones, and the skeleton is now carefully set up in the small museum in that city. It is 48 feet long, and part of the whale-bone remains in the jaw. There are also bones of a whale found in the sands at Deva in the same museum. I was given part of a whale's rib dug up on the Lequeitio beach, and a jaw-bone which was long in the court-yard of the palace of the Count of Revillagigedo at Gijon, is now preserved in the Jovellanos Institute, in the same town. Of course there must be any number of

bones buried in the sand of the beaches where so many hundreds of whales have been flensed in former centuries.

In 1878 the accomplished historian of Guipuzcoa, Don Nicolas Soraluce, printed a pamphlet at Vitoria on "the origin and history of the whale and cod fisheries," which contains much interesting information. I may add that Señor Soraluce is preparing some additional chapters on the whale-fishery, and that he expects to obtain copies of interesting documents relating to the same subject from the archives of the Ministry of Marine at Madrid.

A SYSTEM OF METEOROLOGICAL OBSERVATIONS IN THE CHINA SEAS

IN a recent article in NATURE we referred to the proposal to establish an observatory at Hongkong under the superintendence of Major Palmer, R.E., and expressed a hope that Mr. Hart, of the Chinese Maritime Customs, would be successful in his efforts for the establishment of a number of meteorological stations along the coast of China. The China seas, on account of their numerous currents and destructive typhoons, are especially dangerous to shipping, and the value, in a material sense, of a thorough and accurate series of observations of this kind can hardly be overrated. Moved by these considerations, the Shanghai General Chamber of Commerce, the most numerous and influential foreign mercantile body in the Far East, has taken the matter in hand, and at a recent meeting, reported in the *Celestial Empire*, discussed "the feasibility of organising a system of meteorological reports from the China coast and the interior, with the view of improving the knowledge of the origin and direction of storms, and warning mariners of their approach." The Chamber wisely consulted the Reverend Father Dechevrens, director of the Jesuits' Observatory at Siccawei, not far from Shanghai, who recommended that the object of the system should be twofold :—(1) To give shipmasters a sufficient knowledge of the meteorology of Chinese and Japanese waters to enable them at all times, and especially at critical moments, to recognise the best routes to follow in order to reach their destinations as speedily as possible, and emerge with credit from storms which they have been unable to avoid ; and (2) to give vessels about to leave the port notice of the winds and weather they will probably meet during the subsequent twenty-four hours. The Siccawei Observatory will be able to accomplish both these ends, provided it receives the co-operation of the various shipmasters resorting to the coast of China. It is recommended that every vessel should be provided with a register in which at stated intervals during the day the conditions of the barometer and thermometer, the direction and force of the wind, and the quantity of rain are accurately recorded. In addition to these the various lighthouse keepers and officers at Custom stations along the coast should keep a similar register. The director of the observatory will have in these numerous observations a basis on which to work, and his investigations and the result will be made public as widely as possible.

Father Dechevrens then proceeds to describe what is already known of the meteorology of the China seas. Two kinds of storms prevail there, those from the north, which may be called the storms of winter, or the northern monsoon, and the typhoons, which are, properly speaking, storms of summer, or the southern monsoon. The first come from the interior of Asia and travel towards the North Pacific from west to east, while the second generally remain confined to the neighbourhood of the Philippines, Formosa, and the Gulf of Tonquin. In order to study these storms more effectually, the observatory should receive, twice daily, meteorological observations from Manila, Hongkong, Amoy. Tientsin, Nagasaki, and Vladivostock. By these means warnings can be rapidly conveyed to and from Shanghai of storms coming either from the north or south. The observatory at Siccawei, moreover, should be connected by telephone with the foreign concession in Shanghai, and Father Dechevrens offers the services of one of his observers for the Shanghai end of the line. The Director concludes his Report with the observation that the work will not be one of a day, for everything is yet to be done. "The meteorology of these countries must be commenced at its foundation."

The recommendations contained in this Report were all adopted by the Chamber of Commerce, the members taking on themselves all the financial and business management of the undertaking. The owners of vessels and the Chinese Customs were called upon to supply the instruments necessary for observing, which were those recommended by the Meteorological Office in London, and already in use in some British mail steamers. The agent of the Great Northern Telegraph Company has promised to transmit the daily reports free of charge, and it is anticipated that the Chinese authorities and the local underwriters will contribute the funds necessary for carrying out the project.

Taken in conjunction with the establishment of a complete observatory in Hongkong, for which, as we have already mentioned, the Colonial Government has liberally provided, the scheme above described is one of much scientific and practical importance. Although several observatories are already in existence at various parts of the China seas, no combined attempt has been made to study systematically the meteorology of these regions. The project which has now been adopted by the Shanghai Chamber of Commerce helps to bring to a focus a number of observations which, taken singly, are of small value, but when collected and examined by competent scientific men, cannot fail to produce beneficial results

THE AURORA [1]

II.

AS we have said, it was not uncommon at the *Vega's* winter quarters to see two or more auroral-arcs, one of which was generally the "common arc." The second was nearly parallel to it and separated from it by an unlighted space which was sometimes crossed by rays of light. It would be most important for a thorough knowledge of auroræ to know the true mutual position of the arcs ; but here again simultaneous measurements at two distant places are necessary, and not having such, Nordenskjöld remarks that three suppositions may be made. First, that the two arcs have irregular positions with regard to one another ; secondly, that they are superposed on one another, having their centres on the same axis perpendicular to the surface of the earth ; and third, that their centres are on the same radius of the earth, and that they are situated in about the same plane. In all three cases the aspects of the arcs would be quite different. The observations at the *Vega's* wintering place prove that the last case is the rule, and that arcs irregularly situated with report to one another, or crossing one another (which would correspond to the first and second supposition), are exceptions ; and Nordenskjöld arrives at the conclusion that the auroræ-arcs which were seen from the *Vega*, were usually in about the same plane. It might be asked, however, if it were not more natural to suppose that both rings are at the same distance from the earth's surface, their centres being situated on the same radius of the earth ? But on March 14 two parallel arcs appeared, and soon joined together into a broad belt, the interior edge of which was 5°, and the exterior one was 15° above the horizon, both edges being quite concentric,

[1] A. E. Nordenskjöld, "Om norrskenen under *Vegas* öfvervintring v.d Berings Sund, 1878-79," in "*Vega* Expeditionen Vetenskapliga Arbeten." (The Scientific Work of the *Vega* Expedition, part 1, pp. 401-452.) Continued from p. 321.

and the belt showing a tendency to divide into parallel bands, whilst its brilliancy remained the same towards the lower and upper edges; Nordenskjöld considers therefore as most probable that all the luminous sheet afforded by these arcs was in the same plane.

The rays which sometimes, but rarely, appeared during the arc-aurora also confirms the supposition. They were usually cast from the interior arc towards the exterior and reached its edge, but never went beyond it. On the contrary, when the aurora was intense, new rays were cast

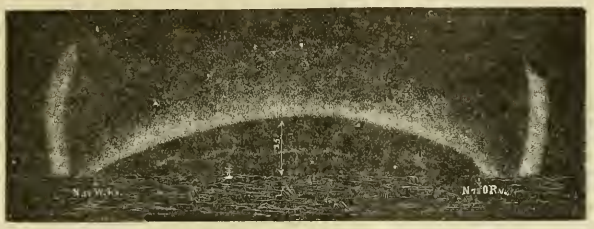

FIG. 3.—Aurora at the *Vega's* winter-quarters, March 3, 1879, at 9 p.m.

FIG. 4.—Double aurora-arcs seen on March 20, 1879, at 9.30 p.m.

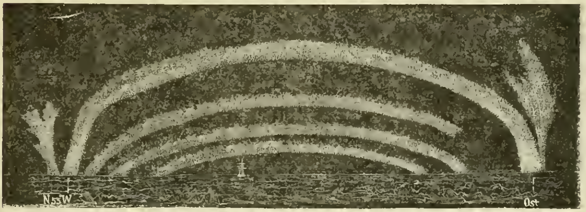

FIG. 5.—Elliptic aurora seen on March 21, 1879, at 2 15 a.m.

FIG. 6.—The same, at 3 a.m.

from the exterior arc, as well towards the interior one, as in the upper space. These phenomena render it most probable that these rays (which must not be confounded with those which form the draperies during strong auroræ) are in the same plane which passes through both luminous circles. If these two circles were situated in the same upper strata of our atmosphere, it would be reasonable to suppose that the rays which flow from one to

another are also in the same strata. In this case they could not be rectilinear, but must flow upon curves drawn by a radius equal to the distance from the crowns to the centre of earth; therefore, when seen from the *Vega's* winter quarters, the rays which were cast 50° or 60° from the edge of the luminous arc, would appear only exceptionally as straight lines; usually they would show a regular curvature of several degrees. But neither at Kolutchin Bay nor at other places did Nordenskjöld remark such a curvature, and he concludes that the common aurora-glory must be produced in a plane perpendicular to the earth's radius, which passes through the aurora-pole. But it is possible also that the long exterior rays may have quite another direction than those which connect together aurora-rings; and whilst these last are cast in the plane of the aurora-glory, the former may be launched in the direction of the inclination-needle.

A drapery-aurora was seen but once at the *Vega's* winter-quarters. But sometimes the common arc rose more above the horizon, or changed its bearing; or new arcs, quite different from the common one, appeared. Sometimes, as, for instance, during the night of March 3 to 4 (Fig. 3), the bows crossed one another. In general the feeble auroræ were quite regular, whilst the more intense afforded more or less irregularity. But even these latter usually began with the appearance of the common faint arc; this soon increased, divided into pieces by the appearance of brilliant knots—not divided, however, into rays—and flame-like knots maintained for a long time the same position, sometimes in the neighbourhood of the arc, but mostly in the north-eastern part of the sky, sometimes also in the zenith. From these knots were thrown flames of equally diffused light (not divided into rays), often, as it seemed, perpendicular to the plane of the glory, and in such case spreading to a very great height above the surface of the earth. The aurora of March 3 to 4 was remarkable for the number of arcs which appeared; towards 9.30 p.m. they crossed one another at their north-western extremities, but disappeared after eleven o'clock, so that at midnight only the common arc was seen. But about one o'clock another series of arcs appeared towards the west, the outer being tangential to the common arc near the horizon, much like to a double solar halo.

Another interesting aurora was seen on March 20 to 21 (Figs. 4, 5, and 6). It was remarkable by the extension and great size of the arcs, by their elliptic shape, and by the circumstance that the short axes of the ellipses were not vertical above the horizon, but inclined, sometimes to the right (Fig. 5) and sometimes to the left (Fig. 6). It seems as if the plane of the glory was slowly oscillating for some 4° or 5° on both sides of its usual position.

On March 30 to 31 there appeared a great number of arcs, which were seen all at the same time. Of six arcs, only two were in the north-eastern part of the sky, whilst the summit of the third was nearly at the zenith, at a height of 80° and three others were beyond the zenith, their summits being respectively 105°, 125°, and 135° distant from the north-eastern horizon.

It is most important to determine where, and under what aspect, the aurora-glory is visible in different parts of our globe, and Nordenskjöld gives special attention to this subject. The second (outer) ring and its rays can be seen over a very great surface of the northern hemisphere. If the rays which were seen from the *Vega* as flowing from this ring to the zenith were cast in the plane of the glory, and if they were cast from all parts of the ring, they must have been seen over a circle drawn from the aurora-pole by a radius measuring 5000 kilometres on the surface of the earth. This circle would include North America as far as California, England, France, and the northern parts of the Iberian Peninsula, Austria-Hungary, Crimea, Siberia, and Northern Sakhalin. But the rays often passed beyond the zenith of the *Vega*, and thus the region of their visibility must be still further increased, including Mexico, Spain, Morocco, Greece, Asia Minor, a part of Turkestan, and Mantchuria; that is, even such tracts where auroræ very rarely occur. But Nordenskjöld does not maintain that all auroræ observed in Europe were due to rays cast from the glory in its plane. He thinks it would be too bold an assertion, as it would mean that thousands of observers were in error as to the idea they got of the direction of rays. But it is probable that a certain part of radiant auroras observed in Europe are due to rays cast in the plane of the glory, and not to rays cast in the direction of the inclination-needle. As to the drapery-aurora which was seen once during the *Vega's* wintering, it seemed to have had its seat nearer to the surface of the earth. Such auroræ are obviously in the same relations to the common arc as the irregular winds and storms of the north are to the regular trade-winds of the south.

On the contrary, the space where the common ring of the glory is visible is very limited. Its projection on the earth's surfacce would be a circle drawn from the aurora pole by a radius of 18°, measured on the surface of our globe. And if its height above this surface is 0·03 radius of the earth, it must be seen above the horizon in a belt 14° wide on both sides of this projection. But to be observed its faint arc must have a height of at least 4° above the horizon, and so the belt of visibility of the common glory-ring is still less. Besides, if the aurora-glory is in reality a ring of light of small thickness situated 200 kilometres above the surface of our globe, it will not be visible in those parts of the earth where it appears in the zenith; there it would appear as a too faint diffused girdle of light about 60° wide, and most probably would not be perceived.

Therefore we must have five different regions situated around the aurora pole, where the glory would appear under quite different aspects. These five regions are represented on the map, Fig. 7, which is a reduction of Nordenskjöld's map.

In the first circular region around the aurora-pole (I. on our map), inscribed in a circle drawn from the aurora pole with a radius measuring 8° on the surface of the earth, the glory is visible only as a luminous mist, or as a very low bow, in a direction opposite to the aurora-pole. As the projection of rays within the common arc seems to be very rare, the aurora phenomena is very rarely to be seen in this region. Very many Arctic explorers have visited this region: Parry, Ross, McClintock, Kennedy, Osborn, Saunders, Belcher, Hayes, Kane, Hall, Stephenson, and Nares, have wintered within it; but among their careful and varied observations auroræ occupy quite an insignificant place—a circumstance very remarkable, as it is obvious that auroræ cannot be overlooked by Arctic travellers, being the only variety during the long Arctic nights. Parry saw auroræ as a feeble diffused light in the south-west; Hayes saw but three auroræ; and Capt. Nares says: "Light flashes of aurora wera occasionally seen on various bearings, but most commonly passing through the zenith. None were of sufficient brilliancy to call for notice. The phenomena may be said to have been insignificant in the extreme, and, as far as we could discover, were totally unconnected with any magnetic or electric disturbance."

The second region (II.) is inclosed between two circles drawn from the aurora pole by radii 8° and 16° long. The common ring of aurora must be seen in this region as a luminous bow, the upper part of which is situated in a bearing opposite to that of the aurora-pole, that is, about the magnetic south. Ross, Parry, McClure, Mac Clintock, Koldewey, and Nordenskjöld (1872-73) have wintered in this region. Ross, on September 23, 28, and 29, 1818, saw vertical rays in the southern part of the horizon, and Parry, on September 15, 1825, saw a bow 5° or 6° high, which lasted, nearly unchanged, for two or

three hours in the south-east. The observations of the Swedish expedition at Mussel Bay (Spitzbergen) were but very incompletely published, but they were also in accordance with the present views of Nordenskjöld. The interior circle of the bow which was seen from the *Vega*, and which was but 5° above the horizon, must be seen from Mussel Bay, close by the zenith, and therefore nearly invisible; while the exterior part of the common arc appeared as a bow of regularly spread light in the magnetic south. Rays of light were spread from it towards the interior circle, and gave rise to the beautiful draperies which so often were seen at Mussel Bay. When the aurora became still stronger, rays of light were sent out even in the interior circle, from the zenith towards the magnetic north, and then a crown appeared, whose rays seemed to meet together at the place where the inclination needle was directed.

The third region (III of the map) is situated between two circles drawn from the aurora-pole by radii 16° and 20° long. In this region the common arc must be in the zenith, and, as has already been pointed out, it must be less often seen as a bow than as a diffuse light spread upon the sky; but this light is so small in comparison with the ray-auroræ which begin in this region, that it must draw but little attention. The second interior circle of the glory must appear in this region as a bow in the magnetic south, and the common, or the interior one, as a luminous arc in the magnetic north, and both arcs must cast rays to one another through the zenith, from north to south, or *vice versâ*. The region comprises the northern parts of British America, the middle parts of Davis Strait, a part of Southern Greenland, Southern Spitzbergen, and Franz Joseph Land; Maguire, Tobiessen, and Payer wintered in this region. As is known, Weyprecht has given a very good *résumé* of the meteorological observations of the expedition, which correspond to a maximum year of auroræ. There were, during 1872-74, fifty-eight arc-auroræ, thirteen of which had the summits of their arcs in the magnetic north, and twenty-eight in the south, whilst the arcs of seventeen other auroras passed through the zenith, or communicated by rays through the zenith from north to south, or *vice versâ*. Besides, the aurora often began with a diffused light which Weyprecht has described as *Nordlichtdunst* (aurora-mist), and which spread over great parts of the sky. Weyprecht draws special attention to the arc-auroræ, and says: "Separate rays are not seen in them. The arc has but a moderate brilliancy, which is equally distributed throughout its surface. Intense auroræ never appear in the shape of arcs. The arc characterises the regular and quiet form of the phenomenon." [1]

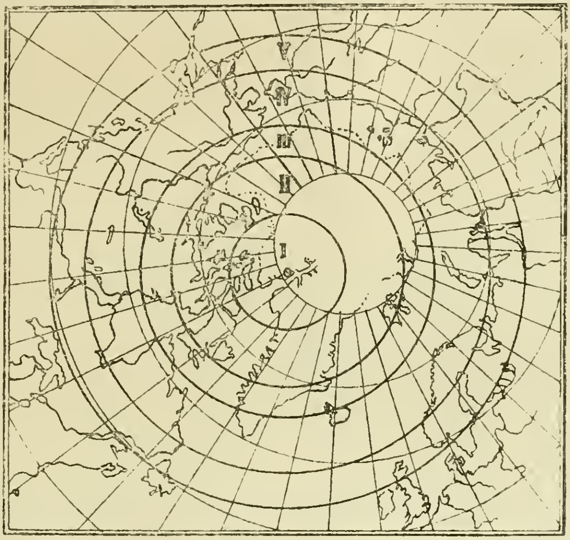

FIG. 7.—Map showing the visibility of the common aurora-glory in the northern hemisphere (reduced from Nordenskjöld's map).

The fourth region (IV. of Fig. 7) is a belt drawn by two radii 20° and 28° long. It passes through Northern Siberia, British America, the southern extremity of Greenland, Iceland, Northern Scandinavia, and Novaya Zemlya. In this region the auroræ usually begin with a luminous bow in the magnetic north, out of which spread radiant beams of more or less intense light, either into free space or to another ring parallel to the former, but lying higher above the earth's surface. The observations of Wrangel and Anjou, and those of the *Vega* were made in this region, as well as those made in Iceland, Southern Greenland, and in the middle parts of British America; but Nordenskjöld did not have these last at his disposal. Wrangel has given much attention to auroræ and, so far as can be judged from the incomplete information published in his "Travels" and in Parrot's account of Wrangel's physical observations, they confirm the existence of a permanent luminous ring around a certain point of the earth's surface, in the neighbourhood of the magnetic pole. During his travels on the shore east of the Lena mouth, Wrangel mostly saw bow-shaped auroræ, the summit of which was in the direction N. 12°–22° E. (true).

The fifth region (V. of our map) is inclosed between the

[1] "Die Nordlicht Beobachtungen der Österr. Ung. Arct. Exped.," in the "Denkschriften der Math.-Wiss. Classe der k. Acad. der Wiss., Wien," Bd. xxxv., 1878.

foregoing and a circle drawn around the aurora-pole by a radius 28° long. The interior circles of the glory are not seen in this region, but we see sometimes their rays and the exterior rings, less common and less regular. The quiet aurora is rare in this region, but the aurora-storms and the beautiful drapery-auroræ are most usual.

It is obvious that the frequency of auroræ must be different in the different regions represented on the map (Fig. 7). They must be most frequent in region IV., as in this we may see both the common glory and the drapery-auroræ, which arise at a greater distance from the aurora-pole, and probably nearer to the surface of the earth. Towards the north this region is bordered by a belt where auroræ must be less frequent, and which, in its turn, includes another belt of a maximum frequency of auroræ, where the arc-aurora must be most common; but the drapery-auroræ are below the horizon. In the circular region around the aurora-pole itself, even the common arc is below the horizon, and therefore auroræ must be rare. Therefore Nordenskjöld observes that his map is much like that of the frequency of auroræ published by Prof. Fritz (*Petermann's Mittheilungen*, 1874, p. 374). Besides, the visibility of auroræ depends upon the position of the sun, and Nordenskjöld observes that it seems that the aurora-arc disappears, or at least becomes invisible, as soon as the sun's rays illuminate that part of our atmosphere where the aurora-ring has its seat. Calculating on this principle a table of the hours when the aurora-arc must appear and disappear for an observer stationed at the *Vega's* winter-quarters, he finds that the disappearance of the aurora in the morning is in accordance with this supposition, whilst its appearance in the evening seems to be independent of this cause, as it used to appear about nine o'clock.

As to the relation of auroræ to terrestrial magnetism, this will be better seen when all the observations of the *Vega* are published. But Nordenskjöld remarks that the "common arc," so long as it was not transformed into more intense forms of aurora, did not exert on the magnetic needle any influence which might not have been included in the usual observations of variations. But the more intense auroræ exerted such an influence, and when the aurora was on the increase, the declination showed a small tendency to a deviation towards the west, whilst the intensity varied much: the horizontal component diminished, and the vertical one increased, especially as the auroræ approached the zenith.

Nordenskjöld tried also to make some spectral observations on auroræ, and he observed the usual greenish-yellow line, together with a bluish-grey spectrum towards the violet end. But the observations were rendered so difficult by the fearful frosts that he could not succeed in making more detailed measurements.

He concludes his most interesting memoir on auroræ with the following words:—"When writing this contribution to our knowledge of the position of auroræ in space, I had at my disposal but few former works on this subject. I must especially regret that our very rich library of travel did not contain the works of Mairans, Bravais, Fritz, Loomis, &c. After returning home I discovered that a method of determining the height of auroræ similar to mine was proposed by Fr. Chr. Mayer (Comment. Acad. Scient. Petropolitanæ, part 1, p. 351, St. Petersburg, 1728), and applied, among others, by Torbern Bergman (*Kgl. Vet. Akad. Handlingar*, xxv., Stockholm, 1764, pp. 193 and 249; xxvii. 1766, p. 224). But Bergman arrived at uncorrect figures, as he supposed that the centre of the aurora ring is situated on the radius of the earth which passes through the pole. Besides, he had no observations upon the *common arc*, and had only measurements of the larger, less regular arcs which are seen from more southern regions. Knowing how little time remains for personal investigation to one who returns from a long exploration in unknown tracts, I have preferred to publish at least a general account of the most important features of the observations I made at the *Vega's* winter-quarters than to postpone the publication for an indefinite time. The want of a larger perusal of former literature upon the subject will probably be excused to some extent by the circumstance that, when writing this, I had the opportunity of continuously comparing the sketch I have tried to draw with the natural phenomena themselves." P. K.

NOTES

THE second ascent of Ben Nevis for the winter was made on Saturday last by Mr. Livingstone, Fort William, to read the thermometer at the station of the Scottish Meteorological Society on the top of the mountain. The depth of snow was found to be much greater at the top than on the occasion of the previous visit. On the edge of the precipices the snow lay to a depth of fifteen to twenty feet, the Ordnance Survey Cairn barely overtopping it, and the hut built for the accommodation of Mr. Wragge during summer being almost completely buried under the snow wreaths. The depth of the snow rapidly diminished in the direction of the protecting-cage for the thermometers, outside which it was only three feet deep. Inside the cage, fortunately, there was scarcely any snow, thus leaving the registering thermometers free. The maximum thermometer read 32°·1, and the minimum 13°·2, these being the extremes of temperature at the top since the date of the previous visit on December 3 (NATURE, vol. xxv. p. 135). The temperature at the time of the visit, 1 p.m., was 31°·4 in the cage, and by *thermomètre froide*, 33°·1. The spring near the summit was deeply buried in snow, but the spring at 2500 feet high was open, and the temperature of its water was 37°·3, the air at the same place being 41°·0. The temperature of the water of the Lake was 42°·1, and that of the air at the same height 44°·8. At Fort William the maximum temperature for the same day was 53°·5, and the minimum in December 23°·5, and in January 26°·8. Hence the temperature at the top had fallen only about 10°·0 lower than the lowest at the level of the sea during the winter. The day was very favourable for the ascent, which was made without difficulty. Though it had rained heavily at Fort William on the Friday, no fresh snow had fallen on the Ben, and as the afternoon sun softened the snow somewhat, the descent was very easy, the first 2000 feet being done in thirty-three minutes. The observations made on these two occasions show that as the snow accumulates to such great depths near the edge of the precipice, the observatory it is proposed to erect should be built at some distance from it.

THE death is announced, on February 8, of Prof. Joseph Decaisne, the eminent naturalist, at the age of seventy-five years.

WE regret to announce the death of Adam von Burg, vice-president of the Vienna Academy; he died on February 1, aged eighty-five. He was well-known by his mathematical and mechanical papers, especially by his "Compendium der höheren Mathematik" and "Compendium populæren Mechanik und Maschinenlehre."

LET us remind our readers that in connection with Captain Abney's lectures there is an interesting Exhibition of Photographic Apparatus and Appliances at the Society of Arts, of which a Catalogue has been issued. The exhibition will be open till February 25 from 10 to 4, and on Wednesday evenings from 6 to 10. Any one interested in photography may obtain admission by applying to the Secretary of the Society of Arts. To-night there will be a demonstration of photography with artificial lights likely to be of great interest.

COLONEL BROWNE and Mr. Simmons have decided to attempt a balloon journey across the Channel from Canterbury, on March 2, or as soon after that date as the wind permits.

THE Mineralogical Museum of the Florence Institute for Superior Studies has become possessed of two remarkably fine specimens of tourmaline and beryl from the granite vein of San Piero, in Campo in Elba. These are represented by chromolithograph plates in the *Rivista Scientifico-Industriale* (January 15). The one granitic piece, 30 cm. long, and 18 cm broad, has 50 tourmalines (mostly of bottle-green colour) implanted in it, all of large size (some 62 mm. long and 12 mm. thick); there are also two beryls and a small crystal of zircon. The other specimen is larger, measuring 40 cm. by 20 cm.; it has 132 tourmalines, 9 beryls, and 3 zircon groups, besides a large quantity of orthoclase, quartz, and albite crystals.

A NEW feature of the journal just named is the addition of summaries, in French, German, and English, of the papers in that portion of the review called the "Giornale del Naturalista." The English, we may remark, is of a somewhat entertaining nature.

AN ascent was made from the La Villette Gasworks, Paris, on Thursday, February 9, with the *Vulcan* balloon. The balloon having ascended to an altitude of 3000 feet, the thermometer, exposed in the sun, showed a temperature of 20° C., and the reading was published in the *Ville de Paris* and other papers of the 10th. It has elicited some astonishment, the weather being rather cold and cloudy. But on the 11th the grass thermometer of Montsouris Observatory exhibited a temperature of 17° C., and a total change of weather was observed. Rain fell in the night of the 11th-12th for the first time after a space of thirty-five continuous days of uninterrupted and unprecedented dryness. The navigation of the Seine had become difficult owing to the low level of the water. During this extraordinary period the electrometer of Montsouris gave without any interruption low readings, and with the exception of a very few instances it had been always positive, although the weather had been foggy for twenty-two days.

AT the annual general meeting of the Teachers' Training and Registration Society, and of the Bishopsgate Training College the other day, Prof. Goldwin Smith took laudable advantage of the opportunity to impress on those present what science teaching really means. "In respect of the teaching of science," he said, "he had constantly brought before him the wide gulf fixed between the two different kinds of what persons call knowledge. The one was a mere learning to repeat a verbal proposition, and the other was knowing the subject at first hand—a knowledge based upon a knowledge of the facts. That which they had constantly to contend against in the teaching of science in this country was that teachers had no conception of that distinction, for they thought it quite sufficient to be able to repeat a number of scientific propositions and to get their pupils to repeat them as accurately as they themselves did. If he might offer one suggestion to the governing body of the college, it was that so far as they taught science at all they should aim at giving real and practical scientific instruction; that it should be confined to those things about which there was no dispute; and that the teacher should be instructed that his business in teaching was to convey clear and vivid impressions of the body of facts upon which the conclusions drawn from those facts were based."

UNDER the auspices of the Dundee Naturalists' Society, a Gilchrist Course of Science Lectures for the People, is now being delivered in Dundee, Perth, Brechin, Montrose, and Kirkcaldy; and in several instances the audiences have only been limited by the size of the lecture-halls. At Dundee and Perth, Mr. Wm. Lant Carpenter's lectures on the Transmission of Power by Electricity were practically illustrated (1) by the Northern Electric Light and Power Company, and (2) by Messrs. Pullar, of the Perth Dye-works, who employ ten dynamos for electric lighting.

ATTENTION has recently been drawn to the commercial value of the Quillaia Tree (*Quillaya saponaria*), a native of Chile, the bark of which has been known for a considerable time both in this country and on the Continent, for the saponaceous principle which it contains. In consequence of the trees having been cut down to obtain the bark there is much reason to fear that the supply may fail, particularly if the demand increases. Quillaia bark, it seems, is very extensively used by wool and silk manufacturers both in this country and in France, in consequence of its efficacy as a powerful cleansing agent. Our contemporary, the *Colonies and India*, in drawing attention to this tree, remarks "that a decoction prepared by placing a small piece of this bark and soaking it overnight in water will remove in a minute or two grease from articles of clothing and leave the cloth clean and fresh as if it was new. It may also be used for cleansing hair-brushes and other similar purposes, under conditions in which soap and other alkalies are powerless. It is also suitable for a hair-wash, and is said to be largely used by French hairdressers, though the mode of preparation is kept secret. Such a tree ought to be invaluable in Australia, New Zealand, Cape Colony, and other colonies where wool growing is a staple industry." Among the uses to which this bark is put may be mentioned tha of a preparation for giving an artificial froth or head to ales, a very small quantity put into beer that has become dead causing it to be covered with froth. The bark occurs in commerce in two forms, that of irregular pieces as taken from the tree, and in the form of powder.

THE Clarendon Press will publish very shortly a "Treatise on Rivers and Canals, relating to the Control and Improvement of Rivers, and the Design, Construction, and Development of Canals," by Mr. L. F. Vernon-Harcourt, M.A., C.E. The author describes the physical characteristics of rivers; the methods and formulæ for measuring their discharge; and the various works, structures, &c., for improving rivers and for forming canals. It contains an account of some of the most important inland canals, and descriptions of celebrated ship-canals. The causes and means of prevention of floods in river-valleys are fully discussed. The past and present conditions of several of the most important rivers at home and abroad are described, together with the successive works of improvement carried out on them, and the results achieved. Each of the various subjects treated of is concluded by a consideration of the value of the different works or methods referred to, and the principles upon which they are based. The book is copiously illustrated with woodcuts and twenty-one large lithographed plates showing most of the works, &c., described.

UNDER the title of "Land and Freshwater Mollusca of India," Col. Godwin-Austen proposes to publish lithographed plates of species of land and freshwater mollusca inhabiting India, Burmah, and adjacent islands in the Indian Ocean. The plates are intended to be of the same size (quarto) as the "Conchologia Indica" of Messrs. Theobald and Hanley, and thus will form a supplement to it. It will include species not published in that work and the numerous species that have since been discovered. Many of the minute forms that have not been sufficiently enlarged in the above work, and which are of little use for identification (for example, those in the genera *Alycæus*, *Diplommatina*, &c.), will be reproduced. Whenever it is possible, drawings of the animals will be given, together with the anatomy of such parts as the odontophore, generative organs, &c., which it is hoped will lead eventually to a better classifica-

tion of the land shells of the region. Each plate will be accompanied by an explanatory page of letterpress. With each issue of the plates, full description of the genera and species, with synonomy and their distribution, will be given in separate pamphlets, 8vo, similar in type to the *Proceedings* of the Zoological Society of London. Col. Godwin-Austen hopes to secure the co-operation of Messrs. H. F. and W. T. Blanford, Sylvanus Hanley, William Theobald, Geoffrey Nevill, Dr. J. Anderson, and others interested in East-Indian conchology. The work cannot be brought out at regular intervals; but whenever a few plates are ready a part will be issued, and it is hoped that at least two parts may be completed during the year. Intending subscribers should communicate with Col. Godwin-Austen, Deepdale, Reigate, Surrey.

IN the January number of the *Archives des Sciences* Professors Dufour and Amstein describe a simple registering barometer, now in use in the Meteorological Observatory of Lausanne. It depends on displacement of the centre of gravity of a glass tube containing mercury. The form of the tube may be described as that of an ∟ leading down to a ∪ by a vertical portion. The lower end is open. The tube swings in the plane of its angles on a horizontal axis placed above the centre of gravity; with increased barometric pressure it inclines to the right, with decreased pressure to the left; and these movements are recorded by means of a style attached to the ∪ part and applied to a moving strip of paper. By a simple contrivance the pendulum of a clock is made to impart a slight shock every second swing to the tube, so as to destroy any adherence of mercury. The instrument is easily made, and proves very sensitive and reliable.

MÜLLER'S imitation of the phenomena of geysers, by means of a vertical tube filled with water and heated in the bottom and about the middle, is open to the objections that we may not assume two places of heating in the actual geyser, and that the eruption of water is only producible once. Herr G. Wiedemann has, therefore, contrived what seems a more suitable apparatus (*Wied. Ann.*, No. 1). It consists of a flask attached to a stand, and having a caoutchouc stopper which supports two glass tubes; one tube 1 cm. wide (beginning flush with the undersurface of the stopper) reaches upwards about 70 cm., projecting through a small basin, and ending with an aperture of diminished section. The other tube (about 3 mm. to 4 mm. wide) passes obliquely upwards, and enters the side of a jar which is about on a level with the top of the vertical tube; at the other end it passes through the stopper, and is bent a little upwards near the bottom of the flask. The cistern is filled with water, and, a Bunsen burner being brought under the flask, the varied action of geysers is very well imitated

MR. ERNEST SATOW, Secretary to our Legation in Tokio, and Lieut. Hawes, have recently produced a work of very great general value on Japan. Although it is entitled "Handbook for Travellers in Central and Northern Japan," and is written after the model of Murray's celebrated Guide Books, it will be found useful to persons who never intend visiting that country. It will be found indispensable to compilers of encyclopædias, gazetteers, and other works of reference. Besides the dry details of routes for travellers, it gives the history of the principal towns and statistical information respecting each. The large mixture of history and legend makes the book tolerably amusing reading even for those unacquainted with Japan. The difficulty of writing a work of this kind for a Japanese scholar cannot be great, as Japanese literature has from time immemorial possessed voluminous guide-books and topographical works. Every Japanese province and district has its own guide, generally containing statistical, geographical, historical, and legendary information. These are illustrated with rude woodcuts representing the principal scenes, temples, idols, &c. The great guide to old Yedo, called the "Yedo Meisho," is an exhaustive work in about fifty volumes. In addition, every road has its little map giving the distances between the various places, the principal inns, the places of interest near the route, and other information of use or interest to travellers. These are either given *gratis* at the inns, or are purchased for about a halfpenny. A tolerably extensive collection of Japanese guide-books is to be found in the British Museum. Although Messrs. Satow and Hawes doubtless used such works as these; the various routes and places mentioned in their volume are evidently described from personal knowledge.

IN a note that appeared in the last number of the Russian Chemical and Physical Society's *Journal*, Mendeleeff points out that Berthelot's hyposulphuric acid is formed under the conditions that generally yield peroxides, peroxide of hydrogen being formed at the same time. It appears to have all the properties of true peroxides, and even combines with water in a similar manner to Barium peroxide. As it does not give salts with bases, the name of acid which is given to it is inexact, and this inexactitude has arisen from a general deficiency of our nomenclature of oxygenated compounds. It is usually admitted that—as in the case of manganese—we have, first, bases, then peroxides, and then anhydrids of acids. But it is well-known that the bioxides of manganese, lead, and others, do not have the characters of peroxides; thus it would be better to call them simply bioxides; true peroxides belong to the type of the peroxide of hydrogen, as true bases and acids belong to the type of water. The highest known oxygen compound of sulphur, S_2O_7, corresponding to Cr_2O_7, which should be termed peroxide of chromium, should be termed sulphurperoxide. Regarded in this way the peroxides generally are bodies in a more oxidised condition than that in which they yield either bases or anhydrides of acids. The peroxides of Barium, sulphur, and hydrogen are the extreme oxidised compounds of these bodies known, and have comparatively neutral qualities.

SOME interesting facts regarding the influence of heat on the molecular structure of zinc are given in a recent paper by Herr Kalischer to the Berlin Chemical Society. Rolled zinc becomes crystalline when strongly heated, and the author recommends as a lecture experiment dipping a heated strip of zinc for half a minute in concentrated sulphate of copper solution, then washing off the precipitated copper with water, whereupon distinct signs of crystallisation appear. The effect is not merely superficial; plates $\frac{1}{20}$ mm. to 5 mm. thick (no thicker were tried) proved crystalline throughout. The mode of cooling (quick or slow) has no marked influence. Zinc when heated, loses its ring, and if bent gives a sound like the "cry" of tin; this fact, with the crystallisation, confirms the view that the cry of tin is also due to crystalline structure. Zinc must be heated over 150° C. to show crystallisation on corrosion, but the "cry" is perceptible at about 130°, and increases with the temperature. As the tenacity of rolled zinc diminishes with crystallisation, and the cry undoubtedly proves incipient crystallisation, some important deductions for technical work are indicated. Herr Kalischer finds the ratio of the specific gravity of zinc in crystalline to that in ordinary state is 1·0004 : 1 or an increase, for the former of about $\frac{4}{100}$ per cent. The ratio of electric resistance of zinc wire ordinary to crystalline = 1·0302 : 1, or a decrease for the latter of about 3 per cent. Herr Kalischer was unable to prove so fully crystallisation in copper, brass, iron, and aluminium, but here were indications of it in some of these.

THE French Commission appointed by the Gambetta Cabinet to report on the position of artistic industries, has not been kept in operation by the new government, but transferred from the French Board of Trade to the Minister of Public Instruction; M. Ferry has been appointed its president. The Commission will appoint special committees, which will visit the principal cities of France.

EARTHQUAKE-SHOCKS were felt on January 23 at Schattwald (Tyrol) at 10.45 a.m., direction west-east, and at Vils, Tannheim (Tyrol), and Oberdorf (Bavaria), at 8 p.m. A shock of earthquake occurred at Bucarest in the night of January 25-26, at 12.30, and at Tecucin and Marasesci (Roumania) on January 26 at 12.25 a.m. On February 5 a shock of earthquake was experienced at Nagy Iglod and Dees (Hungary) at 3.45 p.m., direction north-east-south-west.

THE additions to the Zoological Society's Gardens during the past week include a Malbrouck Monkey (*Cercopithecus cynosurus* ♂) from East Africa, presented by Mr. R. A. St. Leger; a Chacma Baboon (*Cynocephalus porcarius* ♂) from South Africa, presented by Mr. W. F. Battersby; an Amherst Pheasant (*Thaumalea amherstiæ* ♂) from Szechuen, China, presented by Mr. John Biehl; two Crocodiles (*Crocodilus*, sp. inc.) from South Africa, presented by Capt. D. King, R.N.; a Californian Quail (*Callipepla californica* ♀) from California, deposited; two Eagle Owls (*Bubo*, sp. inc.) from South Africa, on approval; a Red-fronted Lemur (*Lemur rufifrons* ♂) from Madagascar, a Common Otter (*Lutra vulgaris*) from Ireland, four Warty-faced Honey-eaters (*Meliphaga phrygia*), two Wattled Ducks (*Biziura lobata* ♂ ♂) from Australia, a Pink-footed Goose (*Anser brachyrhynchus*), European, purchased; a Hybrid Tapir (between *Tapirus roulini* ♂ and *Tapirus americanus* ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE ACADEMY OF SCIENCES, PARIS.—At the annual public sitting of this body on February 6, recommendations of a committee consisting of MM. Faye, Lœwy, Mouchez, Janssen, and Tisserand, with respect to the award of the astronomical prizes of 1881, were adopted by the Academy. The Lalande Prize was awarded to Mr. Lewis Swift, of Rochester, New York, who in the course of four years has discovered seven comets, one of them of short period. The committee remarked that we have now a family of seven periodical comets, of which the aphelion distances do not differ much from the mean distance of Jupiter, and this great planet appears to have drawn them into our system. There are doubtless interesting researches to make on this point of theoretical astronomy: "La première chose à faire est de recueillir de nombreux matériaux; aussi convient-il d'encourager les travailleurs qui consacrent leurs veilles à la recherche des comètes."

The Valz Prize was awarded to Mr. David Gill, H.M. astronomer at the Cape of Good Hope, for his researches on solar parallax, and more especially for the results of his expedition to Ascension, for the observation of Mars at the close opposition of 1877. Mr. Gill has twice applied what is known as *the diurnal method* (first employed by Cassini two centuries since) to observations of Mars with the heliometer. The Ascension expedition is pronounced to have been a great success, twenty-two series of observations of Mars having been obtained, each of which affords a value of the parallax. The discussion of the observations proves that they were made with a high degree of precision, and the committee conclude that "la valeur qui en résulte pour la parallax du Soleil paraît devoir être l'une des plus exactes."

The prizes offered for the year 1882 are those founded by Lalande (a gold medal of 540 francs), by Valz (460 francs), and that instituted in 1863 by the Baronne de Damoiseau. The latter is continued for the same subject as on several previous occasions, when no adequate response was received, and the terms are thus stated:—"Revoir la théorie des satellites de Jupiter; discuter les observations et en déduire les constantes qu'elle renferme, et particulièrement celle qui fournit une determination directe de la vitesse de la lumière; enfin construire des Tables particulières pour chaque satellite." Competitors are desired to give particular attention to one of the conditions—that relating to the determination of the velocity of light. The value of the prize is 10,000 francs; memoirs received till June 1, 1882.

THE TOTAL SOLAR ECLIPSE OF MAY 17.—It appears that astronomy is to be once more indebted to the scientific spirit and munificence of M. Bischoffsheim, the banker of Paris (a valued friend of the late M. Leverrier), who, according to the *Times*, has undertaken the expense of a mission to Upper Egypt, for the observation of this phenomenon. Upper Egypt is about the only accessible locality available on this occasion, and in that district the duration of the total phase will be less than $1\frac{1}{4}$ minute. It will therefore be necessary for the observer to be situate close upon the central line of eclipse to secure a sufficient duration for any useful purpose. Hansen's Lunar Tables, as is well known, require correction at this time, but it happens that the Lunar Tables adopted in the "American Ephemeris" give the moon's place in pretty close agreement with that resulting from Hansen's, with Newcomb's corrections applied, and the track of total eclipse given in detail in that Ephemeris may be taken as almost as reliable a prediction as it will be possible to make. We extract as follows:—

	Greenwich Mean Time	N. Limit Long. E.	N. Limit Lat. N.	Central Line. Long. E.	Central Line. Lat. N.	S. Limit. Long. E.	S. Limit. Lat. N.
	h. m.	° ′	° ′	° ′	° ′	° ′	° ′
May 16 ...	18 20 ...	28 39·9 ...	25 17·5	28 55·8 ...	25 8·0	29 11·7 ...	24 58·5
	18 25 ...	31 21·4 ...	26 42·5	31 37·0 ...	26 31·9	31 52·6 ...	26 21·3
	18 30 ...	33 50·8 ...	28 0·6	34 6·1 ...	27 48·9	34 21·4 ...	27 37·2
	18 35 ...	36 11·5 ...	29 12·8	36 26·4 ...	29 0·2	36 41·3 ...	28 47·6

The duration of totality upon the central line, assuming the sun's semi-diameter 15′ 50″·8, and the moon's geocentric semi-diameter 15′ 51″·9, will be at the above Greenwich times respectively, 1m. 6·3s., 1m. 12·0s., 1m. 17·1s., 1m. 21·8s.: an observer proceeding beyond the intersection of the central line with the Nile, say to Ras Mahomed at the extremity of the peninsula of Sinai, will not therefore secure an increase of ten seconds in the length of the total obscuration. We hear reports of an intention on the part of several American astronomers to visit Egypt for the observation of the eclipse, and hope this country may not be unrepresented.

THE TRANSIT OF MERCURY, NOVEMBER 7, 1881.—This phenomenon appears to have been well observed in Australia. If the times of internal contacts are founded upon Leverrier's tables of sun and planet, and the semi-diameters he deduced from a discussion of the transits of Mercury to 1845, the Melbourne observations indicate that the computed time of first internal contact is too early by 24·5s., and that of last internal contact by 26·0s. According to the observations of that able amateur, Mr. Tebbutt, at Windsor, N.S.W., these errors are respectively 20·8s. and 27·3s. The calculations of the American ephemeris, where Leverrier's old theory of the planet (*Connaissance des Temps*, 1848) is adopted, exhibit much larger errors, at least as regards the exterior contacts, for which alone the formulæ of reduction for parallax are given. The experience is therefore the same as at the previous transit on May 6, 1878.

GEOGRAPHICAL NOTES

AT the meeting of the Geographical Society on Monday last, Sir Richard Temple delivered a lecture which nominally dealt with the geography of the birthplace and cradle of the Mahratta power in Western India, but practically became rather a disquisition on the history of the race, and much of the information furnished will, no doubt, have been familiar to readers of Meadows Taylor's work.

SOME further fragments of news have come from the rescued members of the *Jeannette* expedition. Every effort is being made to find Captain De Long and his companions, but at this season, and in such a region as the Lena mouth, the searchers have a hard task before them. Lieut. Danenhauer sends some interesting notes on the course taken by the *Jeannette*:—"We discovered Jeannette Island May 16, 1881 (?), in lat. 76° 47′, long. 158° 56′ E. It was small and rocky, and we did not land upon it. Henrietta Island was discovered May 24, in lat. 77° 8′, long. 157° 43′ E. We visited it, and found it to be an extensive island, animals scarce, many glaciers. A very large island, found in lat. 76° 38′, long. 148° 20′ E. was named Bennett Island. On it we found many birds, old horns, driftwood, and coal; no seal or walrus; strong tidal action; bold and rocky. The south cape we named Emma. The general health of the crew during twenty-one months was excellent, no scurvy. We used distilled water, bear and seal meat twice a week, but no rum. Divine service was held regularly. We took plenty of exercise, and everybody hunted. Game was scarce, but we got thirty bears, 250 seals, and six walrus; no fish or whales seen. All possible observations were made during the

drift, the result showing north-westerly course, the ship heeling over, and being heavily pressed by ice most of the time. The mental strain was heavy on some of us. The result of the drift during the last five months was 40 miles by tidal movement of ice; very rapid drift the last six months. Soundings pretty even—18 fathoms near Wrangel Land, which often visible 75 miles distant. The greatest depth was 80 fathoms; average depth, 35; bottom, blue mud; shrimps plentiful; meteoric specimens got from bottom; surface water temperature, 20° above zero. The extremes of temperature of air were—cold, 58° below zero (Fahrenheit); heat, about 44° above. During the first winter the mean temperature was 33° below zero, second winter 39° below. During first summer mean temperature was 40° above zero. The heaviest gale showed a velocity of 50 miles an hour, but such gales were not frequent. Barometric and thermometric fluctuations were not great. There were disturbances of the needle coincident with the auroras. Telephone (?) wires were broken by the ice movements. Winter's growth of ice was 8 feet. The heaviest ice seen was 23 feet thick. During the first week of the retreat from the *Jeannette* we drifted back 27 miles more than we could advance. The snow was nearly knee-deep. The naturalist's notes were saved, but the photographic collection was lost with the ship. Lieut. Chipp's 2000 auroral observations were also lost." Thus it would seem that the *Jeannette*, like the *Tegetthoff*, was caught in the ice soon after she entered on her task, and was drifted about in it for many months. The islands discovered are doubtless part of the Arctic archipelago which surrounds the Polar area, and of which Franz-Josef Land, the New Siberian Islands, &c., are outliers. The full record of scientific observations promises to be of some value.

WE understand that the Admiralty are unwilling to send a national expedition in search of Mr. Leigh Smith and the *Eira* Expedition, but have at the same time expressed their readiness to propose a grant of 5000*l*. towards the expense of a private expedition.

DR. SCHWEINFURTH is said to have had a letter from the Marchese Antinori, telling him that he has heard in Shoa of the existence of a race of pigmies to the south-east of Kaffa. They are called Dakos by the Kaffa people, and Jukis by the Gallas. From their reported position it is thought probable that they belong to the same race as the Akkas.

M. JOSEPH MARTIN has on exhibition at the French Geographical Society a collection of photographs, maps, mineralogical specimens, &c., which he has made during a long sojourn in Siberia, where he has been engaged in examining gold, silver, and other mines. During his journey he traversed the Ural, where he was chiefly occupied at the Beresofski gold-mines, visiting also several mines of precious stones, iron, &c. He next went to the Ob, where he examined the mountains round Tomsk, afterwards visiting the gold and silver mines in the Altai. Having visited the Upper Yenisei, he made a geological examination of the Baikal region, and then descended the Lena to the mouth of the Aldan, up which he went for some distance. He also visited the Olekma and Vitim rivers, where gold-mines are being worked, and then made some mineralogical researches in the Stanovoi Mountains. He visited the Transbaikal region and a part of Mongolia, and then followed the Chinese frontier from Kiachta to Vladivostock, after which he spent some time in mineralogical investigations on the Amur and the Ussuri, and in other parts of Russia, and Chinese Manchuria. M. Martin intends in April to start on a journey of exploration in the Kamchatka peninsula.

THE Dépôt de la Guerre at Paris has just published the first four sheets of a map of Africa, which, when finished, is to consist of sixty sheets. This map has been prepared by Capt. Lannoy.

IN a paper which he has read before the French Geographical Society, Col. Veniukof, the well-known Russian traveller, estimates that a third of Asia, as well as a thirtieth part of Europe, still remains to be explored.

THE Lisbon Geographical Society has founded a section in the Azores.

DURING the past year the agents of the London Missionary Society in New Guinea have paid some attention to the previously unknown Maiva district, lying some distance to the west of Port Moresby. In June the Rev. James Chalmers started a second time to visit the region, landing at Miria's village on the Maiva coast. After going to several villages on the coast and in the interior, he determined to visit Madu, the chief of Motu Lavao. Starting from the bight, he ascended a large creek with dense mangrove on both banks—a veritable bed of fever—and then walked through the deserted village of Paitana to Motu Lavao, the path leading through a narrow tract of good country, with dense swamps on both sides. The village was found to be large, with clean and well-kept houses, but situated in a most unhealthy locality. At the end of July Mr. Chalmers again re-visited the Maiva district, in company with the Rev. W. G. Lawes and his wife.

THE Society which was formed at Milan for the commercial exploration of Africa, has already examined the Barka plateau, and founded two stations at Bengazi and Derna, and this year it proposes to send agents to accompany an Arab caravan from the Mediterranean to Wadai, across the desert, and through the oases of Anjila, Jalo, Kufra, and Wanianga. The Society also hopes to obtain the necessary firmans from Constantinople to enable it to establish an agricultural colony to the east of the Barka plateau, and if possible, an attempt will even be made to explore the routes leading from Abyssinia towards Assab, the Italian settlement on the Red Sea.

PHYSICAL NOTES

M. PLANTÉ has found that the long process of "forming" his accumulators is shortened if they are warmed during charging. The temperature best for this purpose is between 70° and 80°, at which limit the opposing electromotive force is somewhat less than when cold, and the resistance a great deal less. He does not find it advantageous to exceed this limit. We venture to suggest that the reason is that at boiling-point the oxygen and hydrogen are evolved in normal conditions, no ozone being produced. The electromotive force of oxygen against hydrogen is less than that of peroxide of lead against metallic lead, and far less than that of ozone against "nascent" hydrogen.

PROF. ANDREA NACCARI has re-examined the question of the unequal heating of the electrodes of a Holtz's induction machine by the passage of sparks. After carefully tabulating his results, he comes to the conclusion that in every case the negative electrode is less heated than the positive; that the heat developed in the spark is not affected by the nature of the metals of the electrodes; that with a constant striking-distance between the ends of the electrodes the heating effect in each electrode is proportional to the quantity of electricity that passes in unit time; and that the quantity of heat thus developed by the passage of the electricity between the electrodes is very considerable.

PROF. MANFREDO BELLATI and Dr. R. Romanese have investigated the rapidity with which light modifies the electric resistance of selenium. The question has a practical bearing upon the construction of the photophone, since, if the time required to produce this change were considerable, the most rapidly vibrating sounds would become confused or inaudible in transmitting them. When light falling on a selenium cell was interrupted 1250 times per second, the resistance was practically the same as with a far less rapid interruption giving equal average illumination. All the experiments of these gentlemen led to the result that selenium behaves sensibly, as if the variation of resistance by the incidence of light were effected instantaneously.

M. LIPPMANN has applied his capillary electrometer to the study of the electric conductivity of shellac, gutta-percha, turpentine, petroleum, and other bodies, which, though insulators, when cold, begin to conduct as their temperature is raised. This subject was investigated in 1875 by Sir W. Thomson and by Mr. (afterwards Professor) Perry, more particularly in the one case of hot glass. In M. Lippmann's experiments a battery of one to forty voltaic cells was placed in a circuit in which the capillary electrometer was included, and in which the substance to be examined was interposed between two platinum plates. At ordinary temperatures the electrometer gave no indication, but moved forward as the temperature was raised to 100° C. As the temperature fell, the substances examined resumed their former state as insulators. A paper on the same subject has, we observe, been recently communicated by Mr. T. Gray to the Royal Society.

M. H. DUFOUR has made an interesting observation of no small importance in the theory of gaseous absorption of radiant

energy. A mixture of chlorine and hydrogen gases diluted with air or oxygen combines slowly in light. Without air the mixture is exploded (as Tyndall has shown in well-known experiments) by exposure to white light, the chemical rays being most efficient. M. Dufour has examined the behaviour of this mixture as to its power of yielding radiophonic and photophonic sounds when illuminated by intermittent beams of different kinds, as in the researches of Graham Bell and Tainter. He finds that the loudest sounds occur when violet and ultra-violet rays are employed, no sound whatever being produced by red rays.

WE notice in the last number of the *Journal* of the Russian Chemical and Physical Society (vol. xiii.), a paper, by M. Kraevitch, on the limit of rarefaction which might be obtained by means of mercury-pumps. M. Kraevitch affirms that in such a pump the tube will always remain filled with vapours of mercury, the elasticity of which, at ordinary temperatures, is no less than 0·02 millimetre; the use of desiccative substances cannot make these vapours disappear, as new vapours are immediately formed again. He contests therefore the idea that Mr. Crookes might have obtained in his experiments so low a pressure as 0·00004 metre; and observes that M'Leod's gauge can measure the elasticity of a permanent gas (admitting that the law of Mariotte were true at such low pressures), but that it does not give the elasticity of the vapours of mercury. After a sketch of different air-pumps, he recommends that of Prof. Mendeleeff, with some modifications of his own, the most important of which is intended to eliminate the inconvenience which Mendeleeff's pump has in common with that of Sprengel, namely, the adhesion of an air-film to the glass-tube at low pressures. The rarefaction of the air, he says, can be carried in this pump so far as to reduce the elasticity of the permanent gas to 0·0002 millimetre, the pressure of the vapours of mercury always remaining, however, no less than 0·02 millimetre at the usual temperature of our rooms. In a few hours the rarefaction may be produced as to show the fluorescence of glass at the negative pole and the other phenomena described by Mr. Crookes, and even to stop the transmission of electricity.

THE PRIZES OF THE PARIS ACADEMY

THE following is, in brief, a list of the prizes offered in connection with specified subjects in 1882 and following years:—In 1882: Grand prize of the Mathematical Sciences (medal worth 3000 fr.): Theory of the decomposition of whole numbers in a sum of five squares. Extraordinary prize of 6000 fr.: Progress increasing the efficiency of the naval forces. Plumey prize (medal, 2500 fr.): Improvement of steam-engines, or of steam-navigation otherwise. Damoiseau prize (medal, 10,000 fr.): Revision of the theory of Jupiter's satellites. Grand prize of the Mathematical Sciences (medal, 3000 fr.): Experimental and theoretical study of the elasticity of one or several crystalline substances. Bordin prize (medal, 3000 fr.): Origin of atmospheric electricity and cause of phenomena in thunderclouds. Desmazières prize (medal, 1600 fr.): Best work in cryptogamy. Vaillant prize (medal, 4000 fr.): Inoculation as a prophylactic in contagious diseases of domestic animals. Grand prize of the Physical Sciences (medal, 3000 fr.): Distribution of marine animals on the French coast. Du Gama Machado prize (medal, 1200 fr.): On coloured parts of the tegumentary system of animals, or on the fecundating matter of animated beings. Breant prize (interest on 100,000 fr.): Cure of Asiatic cholera. Godard prize (medal, 1000 fr.): Anatomy, physiology, and pathology of the genito-urinary organs. Lallemand prize (1800 fr.): Work on the nervous system. Gay prize (2500 fr.): Marine lacustrine and terrestrial deposits on the French coasts in the present period, and especially since the Roman epoch. In addition, there are the Montyon prize in Mechanics, the Lalande and Valz prizes in Astronomy, and several others. Then in 1883: Fourneyron prize (500 fr.): Different modes of transmission of force to a distance. Grand prize of the physical sciences (medal, 3000 fr.): Geological description of a region of France or Algeria. De la Fons Melicoque prize (300 fr.): Botanical work on the North of France. Bordin prize (3000 fr.): Influence of medium on the structure of vegetating organs; variations of terrestrial plants grown in water, and of aquatic plants in air; explain by direct experiments the special forms of some species of maritime flora. Bordin prize (medal, 3000 fr.): Palæontology of France or Algeria. Grand prize of the physical sciences (medal, 3000 fr.): Histological development of insects during their metamorphoses. Alphonse Penaud prize (3000 fr.): Aërial locomotion. In 1884: Sener prize (7500 fr.): On genera embryology applied as much as possible to physiology and medicine. In 1885: Dusgate prize (2500 fr.): Diagnostic signs of death and means of preventing precipitate inhumation. In 1886 the Jean Renaud prize will be awarded for the most meritorious work during five years.

SYMBIOSIS OF ALGÆ AND ANIMALS

A CORRESPONDENT sends us the following as an epitome of K. Brandt's experiments on the green bodies found in the bodies of *Hydra*, *Spongilla*, *Stentor*, &c.:—

When the green bodies are removed from these organisms by crushing, they are found not to be entirely and uniformly green like the chlorophyll-bodies of plants; in addition to the green substance they consist also of colourless protoplasm. Treatment with hæmatoxylin always reveals a definite cell-nucleus; and the same is the case if first killed by 0·2 per cent. chromic acid or 1 per cent. superosmic acid, then freed from chlorophyll by alcohol, and finally treated with solution of hæmatoxylin. These green bodies do not therefore correspond to the chlorophyll-bodies of algæ, but are themselves independent organisms, unicellular algæ. To those found in the animals named above the author gives the generic name *Zoochlorella*, to those which occur in the Radiolaria, Actiniæ, &c., the name *Zooxanthella.* Experiment proved that they are capable of carrying on an independent existence after removal from the animal in which they are found, and are able to produce starch-grains. They can also enter into the bodies of other animals which feed on those that contain them. The physiological function of these algæ was investigated in the case of those which form the well-known "yellow cells" of the Radiolaria. These were found to be of service in supplying food to the host, which thrives best in perfectly pure filtered water. So long as the animals contain few or no green or yellow algæ, they are nourished, like true animals, by the absorption of solid organic substances; but as soon as they contain a sufficient quantity of these algæ, they are nourished, like true plants, by assimilation of inorganic substances. In the latter case the algæ which live in the animals perform altogether the function of the chlorophyll-bodies of plants. Finally the author compares the mode of life of these *Phytozoa* (as he terms the animals which subsist on the algæ contained within them) with that of Lichens. With the Phytozoa there is, however, this remarkable peculiarity, that morphologically it is the alga, physiologically the animal which is the parasite.

NOTES ABOUT SNAKES

A SERPENT'S first instinctive impulse of self-preservation, like that of every other animal, lies in escape; probably a more nervous creature does not exist. If surprised suddenly, or brought to bay at close quarters, it may be too terror-stricken to attempt flight; then it *bites*, following a curious general rule which seems to obtain throughout nearly the whole animal world, from a passionate child downward, no matter what the natural weapons of offence may be. Young *Felidæ* will keep their talons sheathed until they have exerted all possible force with their soft milk-teeth, and a lizard will seize the hand which restrains it with its insignificant little jaws, when its tail or claws might inflict far more injury. The *Boidæ* never use their constrictive powers in self-defence (unless they are gripped), and it seems probable that if a venomous snake's fangs lay in its tail, it would use its teeth *first* when attacked before bringing them into play. Indeed it must be remembered that very few animals are provided with exclusively defensive weapons, and that the python's enormous strength in constriction, the viper's poison apparatus, the lion's teeth and claws, and the electric discharge of the gymnotus are given them primarily for the purpose of securing their food.

A snake *runs* away, walking along on the points of its numerous ribs with a rapidity which can only be appreciated by those who have seen a long one—*Herpetodryas*, for instance—escaping in the open or over the bushes when alarmed, its speed being further increased by the body being drawn up at intervals into folds, which, being extended, shoot the head forward. This is the swiftest mode of progression of which a snake is capable, and is, as I have said, difficult to be realised from the spectacle of these reptiles in cages; the Brazilian neck-marked snake (*Geopytas collaris*), at the Zoological Gardens, will perhaps con-

vey some idea of it, being certainly the most agile denizen of the Reptile House. But this movement is only an increase of the same action which is observed in one creeping slowly along, displayed to best advantage when it is gliding from a plane to a raised surface. When a snake is in imminent danger, however, it adopts a remarkable motion for the purpose of eluding injury or capture, which motion, though it may be termed, *par excellence*, "serpentine," has, singularly enough, been very little commented upon by ophiologists.

The body is thrown laterally into a series of deep curves, which alternate so quickly from convexity to concavity that it is extremely difficult to touch or aim a blow with precision at any part of it, the lateral movements covering a square of ground, the side of which would be represented by at least two thirds of the snake's length. This motion is clearly protective in its object, and is only exhibited when the straight-onward movement is felt to be insufficient to avoid peril, since the reptile's speed in travelling is greatly retarded by it—necessarily so, as the head turns alternately from side to side at an angle of fully a hundred and twenty degrees to the line of its course, thus describing the major part of the circumference of a series of circles which the body and tail follow. Even a small one on a table will not be picked up without two or three ineffectual efforts, when it wriggles in this way, and I have seen a tiny *Oxyrrhopus doliatus* defend itself so for some moments against the lightning "dabs" of a serpentivorous bird; while a lively whip-snake, which was cruelly thrown to a peccary in my presence, actually twined away among the hog's feet and escaped into the jungle, in spite of the hungry and active animal's attempts to secure it. I was walking in the Botanical Gardens of Rio de Janeiro some time ago, when a lady called my attention to something going away among the ferns. Not being able to see it from where I stood, I jumped down the bank and found myself literally upon an immense green tree-snake, at least nine or ten feet long; I was almost treading on it, but notwithstanding my most energetic efforts to catch such a magnificent specimen with my hands, feet, and the crooked handle of an umbrella, it succeeded in crossing an open space two yards wide, and disappeared into a clump of bamboo, solely by virtue of this lateral movement. I noticed that the intensity of the curvatures caused the ventral plates to be exposed, so that the yellowish under-colour was visible at each contortion; owing, no doubt, to the interlocking of the vertebræ, and consequent expenditure of the excess action in rolling.

This serpent, of course, was harmless, so that there would have been no danger in grasping it; but it emitted a curious sound in its terror, such as I have never heard before or since. It *screamed*, and so loudly, that some people near, who saw nothing of what was going on, thought they heard a child cry. A snake's hissing, the only vocal expression of which the *Ophidia* are naturally capable, is produced simply by the rush of air through the narrow chink by which the trachea communicates with the pharynx, without any complex vibratory apparatus such as exists in mammals, though this may be prolonged for a considerable time on account of the enormous capacity of its single lung. I infer, therefore, that this one had just swallowed something, and that either its windpipe was not properly retracted to its normal position, or that the glottis was partially occluded by a pellet of mucus or (more probably) a filament of some extraneous material, which thus converted the hiss into a sort of whistle—just as boys produce a hideous screech by blowing forcibly on a blade of grass held edgewise between the applied knuckles of their two thumbs. Serpents make all sorts of noises besides hissing, according to their different kinds; Crotali spring their rattles; the carpet-viper (*Echis carinata*) rubs the imbricated scales of its adjacent coils together; the fer-de-lance (*Trigonocephalus lanceolatus*) is said in St. Lucia to give out a series of little taps with its horny extremity; and many others—such as the rat-snake (*Spilotes variabilis*) of South America—certainly indicate their presence when angry by quivering their tails against the ground; but a crying snake would have been a decided novelty in one's collection.

ARTHUR STRADLING

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The date of the commencement of the examination for the Burdett-Coutts Scholarship has been postponed from Monday, February 27 as announced, to Monday, March 6.

SCIENTIFIC SERIALS

The Quarterly Journal of Microscopical Science for January, 1882, contains: H. Marshall Ward, B.A., report on the morphology of the fungus of the coffee disease of Ceylon (*Hemileia vastatrix*, Brk. and Br.), plates 1, 2, and 3. This fungus probably belongs to the Uredines; still some structures, such as the curious spore-bearing head and the long-necked haustoria are opposed to this alliance. The history of the adult fungus from the uredospore, and the formation of the teleutospores, are described and figured.—Dr. F. M. Balfour, on the nature of the organ in adult Teleosteans and Ganoids, which is usually regarded as the head-kidney or pronephros. It would seem probable that, though found in the larvæ or embryos of almost all the Icthyopsida, except the Elasmobranchii, this is always a purely larval organ, which never constitutes an active part of the excretory system in the adult forms.—Dr. K. Mitsukuri (Japan), on the development of the supra-renal bodies in mammalia (plate 4).—Pat. Geddes, observations on the resting stage of *Chlamydomyxa labyrinthuloides*, Archer (plate 5), some very characteristic figures of the resting stage of this strange protean form are given.—J. T. Cunningham, a review of recent researches on Karyokinesis and cell division (plate 6).—Dr. Reuben T. Harvey, a note on the organ of Jacobson.—Prof. E. Ray Lankester, on *Drepanidium ranarum*, the cell-parasite of the frog's blood and spleen (Gaule's Würmschen). This very interesting memoir is illustrated with several woodcut illustrations.—G. F. Dowdeswell, M.A., on the micro-organisms which occur in Septicæmia (plate 7).—Prof. Bayley Balfour, Pringsheim's researches on chlorophyll, translated and condensed (plates 8 and 9).

Journal of Anatomy and Physiology for January, 1882, contains:—J. G. Smith, M.A., observations on the histology of fracture-repair in man (plates vi. and vii.); Dr. H. S. Gabbett, colloid degeneration of the non-cystic ovary with associated vascular changes (plate viii.); Dr. G. E. Dobson, the phalanx missing from certain digits in the manus of Chiroptera; Dr. G. Thin, the histology of *Molluscum contagiosum*; Dr. W. Osler, case of obliteration of the portal vein; Dr. A. H. Young, on the muscular anatomy of the Koala (*Phascolarctos cinereus*), with notes; Dr. M. Hay, on the action of saline cathartics; Dr. J. J. Charles, some researches on the gases of the bile.—Anatomical notices.

The Journal of Physiology, vol. iii., Nos. 3 and 4, January, 1882.—Contents: H. N. Martin and W. T. Sedgwick, observations on the mean pressure and the characters of the pulse-wave in the coronary arteries of the heart (plates 8-10).—H. Sewall, on the polar effects upon nerves of weak induction currents.—E. A. Schafer, on the temperature of heat-coagulation of certain of the proteid substances of the blood.—F. W. Mott and V. Horsley, on the existence of bacteria or their antecedents in healthy tissues (plate 11).—S. Ringer, the action of hydrate of soda, hydrate of ammonia, and hydrate of potash on the ventricle of the frog's heart (plates 12-13).—C. S. Roy, the physiology and pathology of the spleen (plates 14-16).—W. R. Gowers, loss of taste from disease of the fifth nerve.—H. P. Bowditch and W. F. Southard, a comparison of sight and touch (plate 17).—J. N. Langley, on the destruction of ferments in the alimentary canal.—On the histology of the mammalian gastric glands and the relation of pepsin to the granules of the chief cells.—E. A. Schäfer, simple method of demonstrating the alkaloid reaction of the blood.—C. E. Webster, note on the production of the heart-sound.

Morphologisches Jahrbuch. Eine Zeitschrift für Anatomie und Entwickelungsgeschichte, vol. vii. part 3, 1881, contains—Dr. Hans Gadow, a contribution to the myology of the posterior extremities of the reptiles (plates 17-21).—Dr. G. von Koch, on the anatomy of *Clavularia prolifera*, sp.n., with notes on the buds in some Alcyonaria; on *C. ochracea*; on the connection of the buds with the stem in the colony of *C. prolifera*; and on the relationship of the spicules to the ectoderm (plates 22 and 23).—Dr. J. E. V. Boas, on the conus arteriosus and the arch of the aorta in the amphibians (plates 24 to 26).

Niederländisches Archiv für Zoologie.—Supplement Band i. Part 2 (Leiden, 1881), contains the first half of a very valuable paper by Dr. R. Horst, of Utrecht, on the Gephyrea collected during the first two voyages of the *Willem Barents*.—On *Hamingia glacialis*, n.sp., plate i, and a memoir on *Proneomenia sluiteri*, gen. et. sp. nov., with remarks upon the anatomy and histology of the Amphineura, by Dr. A. A. W. Hubrecht,

plate 2 to 4. (This large form of Neomenia from the Barents Sea, measuring from 105 to 148 millim., has afforded the author the opportunity of writing a very exhaustive treatise on its anatomy, in which he acknowledges the generous assistance of Dr. Spengel, Prof. v. Graff, and Ray Lankester).

Revue internationale des Sciences biologiques, December 15, 1881, contains—Elie Reclus, ethnographic studies.—M. Thulié, on the buttock-hump and apron of the Bochiman women.—M. Wagner, on the formation of species by segregation.—Dr. Graham, on the chemistry of panification.

January 15, 1882.—Prof. P. Budin, on a very peculiar disposition of the ova in twin pregnancies.—Moritz Wagner, on the formation of species by segregation (end).—A. Hovelacque, on Buffon as an anthropologist.—L. Dollo, on the toothed birds of the Far West; on Archæopteryx; and on the affinities of the birds.—M. Barral, on the application of electricity to agriculture.

SOCIETIES AND ACADEMIES

London

Linnean Society, February 2.—Chas. B. Clarke, M.A., vice-president, in the chair.—The Rev. B. Scortechini and Mr. J. Marshall were elected Fellows of the Society.—Mr. Thos. Christy exhibited various vegetable fibres and the manufactured pulp obtained therefrom by Mr. C. Ekman's process, whereby excellent paper can be made quickly and economically from all sorts of coarse plant fibre.—An extract of a letter from Mr. Thos. Edward, A.L.S., of Banff, was read and a fragment shown of a supposed rare marine animal got by a fisherman in deep water. Dr. Murie identified it as belonging to the Nemertean worms, viz. *Cerebratulus angulatus*, a marine form found chiefly in the northern parts of the British coasts, but nevertheless seldom seen alive by naturalists. Mr. E. M. Holmes exhibited specimens of a new blistering insect from Madagascar, belonging to the genus *Epicauta*, and allied to *E. ruficollis*.—Mr. Holmes afterwards drew attention to specimens of Cinchona bark cultivated in Bolivia, belonging to the "*Verde*" and "*Morada*" varieties of Calisaya, which hitherto have not been cultivated in the Colonies, but notwithstanding deserve notice on account of the large yield of bark and good percentage of quinine; they therefore pay the Bolivian planters better than the well-known *Ledgeriana calisaya*.—Mr. J. R. Jackson exhibited a specimen of the Australian native "Pituri" bag, their constant companion and solace in travel. Formerly the leaf of the plant was only known, but Baron von Mueller has lately shown from other evidence that it is derived from the *Duboisia Hopwoodi*.—A note by Mr. Otto Tepper on the medical use of *Melaleuca uncinata*, R. Br., was read. He says the dried leaves chewed and the saliva swallowed are a specific in cases of colds, sore throats, and bronchitis, the flavour being aromatic.—A communication from Major-General Benson was read; this referred to Dr. Cobbold's use of the name *Fasciola Jacksoni* for certain flukes obtained from the elephant, the same having been described by Major-Gen. Benson in the *Rangoon Times*, 1867. Dr. Cobbold thereupon explained that the initials of the author having alone been appended to the article in question, it consequently had received less attention than it would otherwise have had. To Major-Gen. Benson certainly belongs the credit of having first directed attention to the elephant mortality from the said species of fluke, though the worm was first discovered by Jackson twenty years before the Rangoon letter appeared, viz. in 1847.—There followed a paper by Mr. Robert Fitzgerald, botanical sketch in connection with the geological features of New South Wales."—Afterwards a paper was read, on animal intelligence, by Mr. Otto Tepper. He described instances under his own observation, of cats regularly unfastening the latch of a door to obtain entrance, and in the case of certain species of ants, their mode of communicating with each other, &c., therefrom adducing a power of reasoning usually attributed to instinct.

Mathematical Society, February 9.—S. Roberts, F.R.S. president, in the chair.—Mr. J. H. Tompson, Science Master in the Auckland College, New Zealand, was elected a member, and Mrs. Bryant was admitted into the Society.—Mr. Tucker read an abstract of a paper by H. M. Jeffery, F.R.S., on plane curves of the fourth order with quadruple asymptotes.—The chairman communicated some results connected with Euler's formula connecting the sum of the divisors of a number with the pentagonal numbers, and remarked that the formula really expressed the equality of the sum of the divisors to the sum of the *m*th powers of the roots of a certain equation.—Mr. J. Hammond and Mr. Tucker also made short communications.

Chemical Society, February 2.—Prof. A. W. Williamson in the chair.—Dr. Odling delivered a lecture on the unit weight and mode of constitution of compounds. The lecturer had originally proposed to bring forward three questions for discussion and consideration—(1) Is there any satisfactory evidence deducible of the existence of two distinct forms of chemical combination, atomic and molecular; (2) Is the determination of the vapour density of a body alone sufficient to determine the weight of the original molecule; (3) In the case of an element forming two or more distinct series of compounds, *e.g.* ferrous and ferric salts is the transition from one series to another necessarily connected with the subtraction of an even number of hydrogenoid atoms. The lecturer limited himself to a great extent to the first question, touching incidentally on the third, and omitting the second altogether. A large portion of the lecture was occupied with a consideration of the valency or adicity of the elements and the effect thereon of other elements in the molecule. From various considerations the lecturer concluded that there is no evidence founded on facts to show that there is any difference between atomic and so-called molecular combination, but that the one passes imperceptibly into the other. There is also no necessary connection between the valency of an element and its chemical condition in forming two series of compounds: thus tin in the stannous compounds is not necessarily a dyad. The lecturer also devoted some time to the consideration of chemical formulæ, and especially to the use of condensed or contracted formulæ.

Geological Society, January 25.—Mr. R. Etheridge, F.R.S., president, in the chair.—John Blaikie, M. Ernest Jobling, and the Rev. Stanley A. Pelly, B.A., were balloted for as Fellows of the Society.—The following communications were read:—On the fossil fish-remains from the Armagh limestone in the collection of the Earl of Enniskillen, by James W. Davis, F.G.S. The author described in this paper a large collection of fossil fish-remains at present at Florence Court, Enniskillen, but which will soon be removed to the new Natural History Museum in the Cromwell Road. The collection comprises, besides specimens collected by the Earl of Enniskillen from the Carboniferous limestone of Armagh, a large series acquired from the famous collection of the late Capt. Jones, M.P., the remaining portion of which is in the Geological Museum of Cambridge. Several genera and species were described by Prof. Agassiz in his "Recherches sur les Poissons Fossiles" (1833-43), and again referred to by J. E. Portlock, F.R.S., in his "Report of the Geology of Londonderry and parts of Tyrone and Fermanagh" (1843). In 1854 Prof. M'Coy described many new genera and species in his work on the "British Palæozoic Rocks and Fossils," principally derived from a study of the portion of Capt. Jones's collection deposited in the Cambridge Museum. Prof. Agassiz paid a visit to Florence Court in 1858, and appended names to some of the fossil teeth in Lord Enniskillen's cabinets, intending to describe and figure the new forms, and to revise the whole of his former work. His death prevented this intention from being carried into effect. As far as possible the determinations of Prof. Agassiz have been adhered to in the present paper. The detached and isolated condition in which the remains are found renders any appreciation of the relationship of the teeth and spines, or even of the teeth only, to each other extremely uncertain and difficult. Some speculations as to the probable organisation and characteristics of the Carboniferous fishes which they represent, evolved during a long consideration of the specimens, have therefore been postponed to a future opportunity.—On an extinct Chelonian reptile (*Notochelys costata*, Owen) from Australia, by Prof. Owen, C.B., F.R.S. The fossil reptilian remains hitherto transmitted to the author from Australia have been limited to parts of the skeleton of *Megalania prisca*, Ow. The present specimen, sent last year by Prof. Leversidge, is the first fossil Chelonian. The specimen was found in a formation at Blinder's River, Queensland, of which the nature and age are not stated. It is, however, petrified. The fossil consists of the anterior porton of the carapace and of the plastron, brought into unnaturally close contact by posthumous pressure. A minute description of the several parts was given, from which the author concluded that though the characters of the carapace might be interpreted as identifying the Chelonian with a true turtle (*Chelone*), those of the plastron

show the well-marked distinctions of *Trionyx* and *Chelys*. On the whole, however, the modifications, especially of the carapace, show a nearer affinity to the marine turtles (*Chelone*) than the known Chelydrians exhibit, and indicate a more generalised type.—On the upper beds of the Fifeshire Coal-Measures, by the late E. W. Binney, F.R.S., and James W. Kirby.

Anthropological Institute, January 24.—Anniversary Meeting.—Major-General Pitt-Rivers, F.R.S., president, in the chair. The following gentlemen were elected Officers and Council for the year 1882:—President, Major-General Pitt-Rivers, F.R.S.; Vice-Presidents: Hyde Clarke, John Evans, F.R.S., Prof. W. H. Flower, F.R.S., F. Galton, F.R.S., Dr. Allen Thomson, F.R.S., E. B. Tylor, F.R.S.; Director, F. W. Rudler, F.G.S.; Treasurer, F. G. H. Price, F.S.A.; Council: Lieut.-Col. H. H. Godwin Austen, F.R.S., J. Beddoe, F.R.S., S. E. B. Bouverie-Pusey, E. W. Brabrook, F.S.A., Prof. Geo. Busk, F.R.S., C. H. E. Carmichael, M.A., W. Boyd Dawkins, F.R.S., W. L. Distant, A. W. Franks, F.R.S., Prof. Huxley, F.R.S., A. H. Keane, B.A., A. L. Lewis, Sir J. Lubbock, Bart., M.P., R. Biddulph Martin, M.P., J. E. Price, F.S.A., Lord Arthur Russell, M.P., Alfred Tylor, F.G.S., C. Staniland Wake, M. J. Walhouse, F.R.A.S., R. Worsley.—The president delivered his annual address, in which he reviewed the work of the past year.

Victoria Institute, February 5.—A paper by Mr. Callard, F.G.S., "On Breaks in the Continuity of Mammalian Life in Certain Geological Periods, Adverse to the Darwinian Hypothesis," was read. A discussion took place, in which Mr. J. E. Howard, F.R.S., Mr. D. Howard, F.C.S., Mr. S. R. Pattison, F.G.S., Mr. J. Mello, F.G.S., Mr. Charlesworth, F.G.S., and other geologists took part.

Edinburgh

Royal Society, January 16.—Sir William Thomson, hon. vice-president, in the chair.—Mr. Patrick Geddes read an interesting paper on the nature and functions of the "yellow cells" of Radiolarians and Cœlenterates, a full abstract of which we have given (p. 303).—Sir William Thomson, in a paper on the thermodynamic acceleration of the earth's rotation, drew attention to a solar action which tends to accelerate the earth's rotation, or more strictly to diminish the retardation effect of the tides. In ordinary tidal action the viscosity of the fluid, supposed distributed uniformly over the surface of the earth, has the effect of so shifting the line of crests as to make the couple due to the action of the tide-producing body upon the protuberant mass to act upon the earth in a direction contrary to that of the earth's rotation, and consequently to retard this rotation. From consideration of observed barometric changes at various stations all over the earth's surface, it is found that the well-known semi-diurnal barometric oscillation has its maxima, on an average, at 10 a.m. and at 10 p.m., and its minima at 4 p.m. and 4 a.m. This barometric oscillation must be due to the action of solar heat; though why the well-marked diurnal temperature oscillation with the superposed feeble semi-diurnal oscillation should result in a large semi-diurnal oscillation of pressure with a small diurnal oscillation superposed upon it, is not easy to explain, unless it be that the period of free oscillation of the atmosphere agrees more closely with the smaller period. However this may be, the existence of an atmospheric tide is proved by barometric observations, and the line of crests, *i.e.* the axis of maximum pressure, so lies with respect to the line joining the earth's centre and the sun that the couple due to the sun's attraction upon the ellipsoidal mass of air acts in the direction of the earth's rotation, and therefore accelerates it. The energy of this acceleration is of course derived from the sun's heat, and hence the appropriateness of the name *thermodynamic acceleration*. Its value, as estimated by Sir William Thomson, is about one-tenth of the tidal retardation.—Mr. Ferguson of Kinmundy communicated notes on a cist discovered near Parkhill, Dyce, Aberdeenshire, in 1881, with a description by Dr. Fife Jamieson of the bones found in it. Besides the bones, which, for the most part were human, and indicated a fairly muscular man with well-developed skull and lower limbs, there was found in it a small urn ($5\frac{1}{2}$ inches high, $4\frac{1}{2}$ inches wide), of graceful shape and elaborate carving. There were also present fragments of the bones of the fore-limbs of a boar and some charcoal—two rare features, the occurrence of the charcoal being apparently a survival of the Pagan custom of cremation.—Mr. T. Muir read a paper on permanent symmetrical functions, representing them by a notation similar to the determinant notation, and indicating some of their properties as well as their relations to alternate numbers and determinants.—Prof. Tait communicated two optical notes, the first of which was a simple geometrical construction of the curve formed by rays of light from a straight slit falling on a screen after passing through a bull's eye shaped irregularity on a window-pane, such as is frequently met with in old panes. Under favourable circumstances this curve may have a cusp, or even a loop. The second note dealt with the difficulty pointed out by Airy in his Tracts regarding the nature of common light, and showed how it can at once be got over by looking at things from the modern statistical point of view which has been so useful in its application to the kinetic theory of gases.

Vienna

Imperial Academy of Sciences, January 19.—L. T. Fitzinger, in the chair.—The following papers were read:—A. Wassmuth, on electromotive bearing powers.—C. Koelter, on the action of an electro-magnet on different minerals, and its use for the mechanical separation of them.—H. Weidel, contributions to the knowledge of tetrahydrocinchoninic acid.—S. Exner, on the function of the musculus crumptonianus.—F. Woehner, results of the observations and stuoies made on the earthquake of Agram of November 9, 1880.

February 3.—L. T. Fitzinger in the chair.—The following papers were read:—A. Adam Riewicz, on the blood-vessels of the spinal cord of man, Part ii., the vessels of the surface of spinal cord.—S. Mayer, contributions to histological technics.—S. Exner, on atrophy and innervation of the muscles of larynx.—F. Lippich, on polaristrobometric methods.—Studies on caffeine and theobromine, Part 3, by R. Maly and F. Hinteregger; Part 4, by R. Maly and R. Andreasch.—T. M. Eder and G. Ulm, on the action of iodide of mercury on hyposulphite of sodium.—C. Langer, on the structure of bones.—V. Hochstetter, report on the researches made by Szombathy in the caves Lettenmayer-hoehle, near Kremsmünster (Lower Austria), Vipustex-hoehle, near Kiritein (Moravia), Lautscher-hoehle, near Littau.—F. Steindachner, contributions to the knowledge of the fishes of Africa, Part 2.—Description of a new species of Paraphroxinus from the Herzegovina, by the same.—T. Herzig, on the constitution of guaiocol.—G. Goldschmidt and T. Herzig, on the action of the lime-salts of the three isomeric oxybenzoic and anisic acids at dry distillation.—G. Goldschmidt, a note on the occurrence of succinic acid in a bark-covering of *Morus alba*.—C. Senhofer, on naphthalene-tetrasulphonic acid.—M. Margules, on the rotatory oscillations of liquid cylinders.

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THURSDAY, FEBRUARY 23, 1882

VIGNETTES FROM NATURE

Vignettes from Nature. By Grant Allen. (London: Chatto and Windus, 1881.)

CERTAINLY Mr. Grant Allen stands at the head of living writers as a popular exponent of the evolution theory. Although the subject is one which he has taken up a comparatively short time ago, he appears to have thoroughly mastered its principles, to have read and assimilated all the best works on the subject, and to have so imbued himself with its leading ideas that he is able to apply it in an intelligent and often original manner to every natural object he meets with in his daily walks or holiday rambles. To these primary qualifications he adds a great power of description, a vivid imagination, and a charming style of writing, all of which are displayed in every page of his last work. This consists of a series of short essays, which originally appeared in the *Pall Mall Gazette*, each giving a sketch of some single scene or natural object, and showing how much interest can be given to the most common things by considering them from the point of view of evolution. "Sedge and Woodrush" furnish an opportunity for the explanation of degraded types and the large part played by "degeneration" in the origin of existing animals and plants. By the common "Red Campion and White" we are shown how, and by what means, species become differentiated; and the subject is further discussed and elucidated in the chapter on a "Bed of Nettles." After showing how the sting of the nettle has originated, and how it protects the plant by stinging the noses of herbivorous quadrupeds, he goes on to discuss the general form of the nettle in a way that is both suggestive and (I think) original.

"But the sting certainly does not exhaust the whole philosophy of the nettle. Look, for example, at the stem and leaves. The nettle has found its chance in life, its one fitting vacancy, among the ditches and waste places by roadsides or near cottages; and it has laid itself out for the circumstances in which it lives. Its near relative, the hop, is a twisting climber; its southern cousins, the fig and mulberry, are tall and spreading trees. But the nettle has made itself a niche in nature along the bare patches which diversify human cultivation; and it has adapted its stem and leaves to the station in life where it has pleased Providence to place it. Plants like the dock, the burdock, and the rhubarb, which lift their leaves straight above the ground, from large subterranean reservoirs of material, have usually big, broad, undivided leaves, that overshadow all beneath them, and push boldly out on every side to drink in the air and sunlight. On the other hand, regular hedgerow plants, like cleavers, chervil, herb-Robert, milfoil, and most ferns, which grow in the tangled shady undermath of the banks and thickets, have usually slender, blade-like, much divided leaves, all split up into long narrow pushing segments, because they cannot get sunlight and air enough to build up a single large, respectable, rounded leaf.

"The nettle is just half way between these two extremes. It does not grow out broad and solitary, like the burdock, nor does it creep under the hedges like the little much-divided wayside weeds; but it springs up erect in tall, thick, luxuriant clumps, growing close together, each stem fringed with a considerable number of moderate-sized, heart-shaped, toothed-and-pointed leaves. Such leaves have just room enough to expand, and to extract from the air all the carbon they need for their growth, without encroaching on one another's food supply (for it must always be remembered that leaves grow out of the air, not, as most people fancy, out of the ground), and so without the consequent necessity for dividing up into little separate narrow segments. Accordingly, this type of leaf is very common among all those plants which spring up beside the hedgerows in the same erect shrubby manner as the nettles. It is almost exactly imitated in the dead-nettle and the hemp-nettle, which are plants of a totally distinct family, with flowers of the sage and rosemary type; and it is more or less simulated by ten or twenty other species of like habit. This peculiarity of external resemblance, under identical circumstances, is a common and a natural one. . . . Whatever the original stock, natural selection tends always under like circumstances to produce like results."

Then we have the diœcious green flowers described, with the curious elasticity and irritability of the stamens, which throw out the pollen dust when the wind blows the plants about, and thus ensures abundant cross-fertilisation.

In the next chapter, "Loosestrife and Pimpernel," we have an excellent discussion on the close relationship of the wood-loosestrife or yellow-pimpernel (*Lysimachia nemorum*) to the true pimpernel (*Anagallis vulgaris*), although placed by botanists in distinct genera. Such remarks as these are very important, calling attention to the fact that the technical characters of botanists, even when drawn from the structure of the fruit, may be really of recent origin, and may not be so important as more superficial resemblances usually treated as of less systematic value. In another article on "A Big Fossil Bone" a popular misconception as to the generally large size of extinct animals is very well corrected. Everywhere we seem to find in fossil forms a bigger animal of each kind than any now existing. Here we have an enormous Irish elk, there an immense extinct sloth, a gigantic armadillo, or a turtle ten times as big as the greatest living member of the tortoise group. But it is apt to be forgotten that the huge Saurians were secondary animals, while the dinotherium was tertiary, the mammoth quaternary, and the moa as well as the epyornis almost modern. It is forgotten that the age of the great reptiles was nearly over before that of the great mammals set in. It is forgotten that the glyptodon lived in South America, while the big elk lived in Ireland; and by picturing a world in which all the great extinct animals were grouped together as they see them in a geological museum, people get a distorted picture which really reverses the actual facts as to the relative size of the animals in the past and the present. For (Mr. Allen remarks)—

"As a matter of fact it seems probable that our actual fauna and flora are on the whole not only quite as big as any previous ones, but even a great deal bigger. If we take single instances, no known extinct animal was as large as some of our modern whales; if we look at the *ensemble* of our existing species, no known period comprised so many large forms as we can show at the present day in our three or four great cetaceans, our two elephants, our rhinoceroses, our bisons, our giraffe, our walrus, and our horses. These would probably form a total assemblage of larger average size than any previous epoch could produce. Similarly in almost every special class, we could apparently show larger species at the present day than any which we know to have existed in fossil forms. Our

whale is the biggest known mammal; our gigantic salamander is the biggest known amphibian; probably our sun-fish, our tunnies, our sharks, and our devil-fish, are each in their way larger than any previous fishes—one living shark actually attaining a length of forty feet. No fossil bivalve molluscs are, to my knowledge, as big as the common Mediterranean pinna, or as that giant clam, the tridacna, whose shell is so commonly used as a basin for fountains. In fact there are only two important groups, the birds and the reptiles, in which extinct species were much larger than existing ones; and in these two groups the decrease is evidently due to the later supremacy of the mammalian type."

He then goes on to show that in many lines of descent we find groups of animals which have steadily been increasing in size from the earliest epoch of their appearance to the present day, as, for example, the horses, the deer, and the elephants. Evolution generally tends towards increase of size in dominant groups; but when a group ceases to be dominant and begins to decay its bigger members die out.

Equally interesting and suggestive are the discussions on colour and the colour-sense, *à propos* of the "Veronica" and the distribution of fishes, in "The carp pond" and "The mountain tarn"; but we pass on to the chapter devoted to "The donkey's ancestors"—a charming sketch suggested by "a dear shaggy old donkey making himself perfectly happy upon a bare rocky hillside, upon four sprouting thistles, a bit of prickly carline, and three square yards of wet turf at the outcrop of a little spring." Let us, however, pass by his pedigree (the same as that of his cousin, the horse), and see what Mr. Allen has to say about his intelligence, and the reason of it.

"Donkeys are the final flower of long ages of native evolution, the natural head and crown of one great line of mammalian development. To doubt their intelligence is to impugn the whole conduct of nature, to upset the entire system of evolutionary psychology off-hand. Donkeys cannot help being clever, because they are the final survivors in the struggle for existence in one of the most specialised, most highly developed, and most dominant mammalian stocks. They do not represent mere stranded and struggling relics of older types, like the very silly kangaroos, and ant-eaters, and hedgehogs, which drag on a miserable existence behind the times in out-of-the-way holes and corners of the earth; they are one of the finest developments of one of the most successful branches of the great ungulate tribe. I feel a genuine respect for every donkey I meet, when I remember that it was the mere accidental possession of an opposable thumb that gave my ancestors a start over his in the race for the inheritance of the earth towards the very close of the tertiary period."

In reading this most entertaining and instructive volume almost every page offers some suggestive remark or apposite illustration of the principle of evolution; and it is very rarely that we meet with anything to which exception can be taken on the score of accuracy. It is perhaps doubtful whether monkeys are "intellectually in the very front rank of the animal world," notwithstanding "the opposable thumb and the highly mobile trunk, with its tactile appendage, give these creatures an exceptional chance of grasping an object all round, and so of learning its physical properties." I am myself inclined to think they are decidedly inferior to dogs, horses, and elephants. So the tracing of man's sense of colour to the fact of our pre-human ancestors having been attracted by the bright colours of the orange, blue, and crimson fruits of tropical forests appears doubtful, if not erroneous; because the colours of such fruits are no indication of their edibility for either man or monkeys, and there is no reason they should be so, since mammalia in eating the fruits would be likely to crush and destroy the vitality of the seeds. At all events many bright coloured tropical fruits are poisonous, while many that are eatable are green and unattractive. Even among our native berries children who trust to enticing colour are apt to be poisoned by bitter-sweet or deadly nightshade. Neither is there any evidence that—

"Up to the beginning of the tertiary period, large evergreens of what is now the tropical type covered the whole world as far as the very poles themselves. Greenland and Spitzbergen then supported huge forests of the same general character as those which now spread over Brazil and the Malay Archipelago."

Nor is Buffon's idea—that organic life must have begun at the Poles, because on the surface of an incandescent planet the poles would be the first part to cool down sufficiently to allow of the conditions under which alone life becomes possible—at all in accordance with the teachings of modern science, as Mr. Allen maintains it to be. For the first cooling of the surface would necessarily occur at a time when the whole of the water of the globe was in a state of vapour, and this vast aqueous atmosphere would so far prevent the heat of the sun from reaching the surface, and so equalise radiation that there need have been no cooling at the poles earlier than at the equator; and when subsequently the water was condensed and oceans were formed, these would equalise temperature over the whole surface, and render it possible for life to originate at one part as well as at another. But these are very slight blemishes in so excellent a book, which is calculated to bring home to every reader how much of interest and novelty, of intricacy, of beauty, and of wonder, is to be found in the structure or history of the humblest plants or the most familiar animals; and also, how greatly the once-decried doctrine of evolution has added to the ideal and poetic aspects of the study of nature.

ALFRED R. WALLACE

THE COMPASS

Traité Théorique et Pratique de la Régulation et de la Compensation des Compas. Par A. Collet, Lieutenant de Vaisseau, Répétiteur à l'École Polytechnique. Ouvrage publié avec l'Autorisation de M. le Ministre de la Marine. (Paris: Challamel Ainé, 1882.)

THIS new treatise on the compass contains an admirable account of the most recent work done on the subject, and a very full and practical explanation of the objects of compass compensation and the methods adopted to secure it. It is founded on the author's translation, now twelve years old, of Smith and Evans' Admiralty Manual—made for the benefit of the French marine. That epoch-making book is however still the basis or substratum of Lieut. Collet's new work.

The practical part of the English book is fully given. M. Collet has added as much elementary mathematics and physics as he thinks may be useful to such seamen

who wish to understand the whole subject from his volume, without reference to auxiliary text-books. To a slight extent he has revised the demonstrations and modified the diagrams of the Admiralty Manual—abridging these demonstrations so far as he thinks it possible to do so. He preserves Smith's notation as generally familiar. The newest part of the book is that in which he gives us the full details of the recent methods by which the amount of compensation can be determined with or without altitudes. In the account of these methods his readers will find collected much that it would be impossible for them to find in any English volume, and the exposition has all the merits of the French school. Smith and Evans showed us in their Manual how to determine the five essential coefficients upon which the deviation, when it is less than 20° in absolute value, depends at any position on the earth's surface, and for any course of the ship, three of these being constant. Two observations of the variation at any place accordingly suffice to determine the values of the deviation. Collet points out the necessity of *compensation*, that is to say, of the reduction of the five constants to insignificant values which can be determined even in a fog, when no observations of altitude can be taken, a method, of course, of the highest importance to practical men in circumstances of actual difficulty, which are constantly recurring. The theoretical part of the Admiralty Manual is given as succinctly as it is perhaps possible to give it if it is to be clearly mastered; the practical part is dwelt upon in full detail, and the rules are so simple and plain that ordinary captains in the merchant service ought to be able to use them accurately, even if they are unable to master the scientific part.

There is an excellent account of Sir William Thomson's compass. The fundamental ideas on which that instrument is constructed are that the magnetised needles must be so small that we may safely neglect their length, and that the intensity of their magnetism must be so slight that there is no reciprocal action between them and the soft iron correctors. The compass card is extremely light. A card of 10 inches diameter is directed by eight small needles, four on each side, like ordinary sewing-needles, of from 2 to 3 inches in length, and weighing in all about $3\frac{1}{2}$ grammes. These are hung by two parallel silk threads, and attached to the card by silk threads passing through the two eyes at the two ends of each needle. The entire weight of the card, the needles, the outer circle of aluminium, the silk threads, the cap which rests on the vertical point, &c., is only 12 grammes, which is about 1-10th of what it is in the ordinary compass. This, of course, gives much less friction than usual between the point and the cap, so that the error due to friction is reduced in practice within a range of a quarter of a degree.

The feeble magnetic moment of the system involves two important consequences—the period of oscillation round the position of equilibrium is only about 40 seconds, whereas it is three times as much in an ordinary compass card, and the suspension by silk threads makes the whole card so elastic that it is much less liable to be prejudicially affected by any sudden shock, such, for instance, as the firing of a cannon on board.

M. Collet gives an account of the compensated compasses of Peichl, a lieutenant in the Austrian naval service. Peichl aims, like Sir William Thomson, to reduce the five coefficients used in determining the deviation to insignificant values. We must refer the reader to Mr. Collet's book to show wherein Peichl differs from Sir William Thomson's system, and wherein M. Collet considers it to be markedly inferior to it in practical value.

The fifth part of the treatise discusses the methods by which it is possible, by the use of Sir William Thomson's deflector, to compensate and to obtain the necessary corrections for the compass in foggy weather, when no observations of altitude, celestial or terrestrial, are possible. These methods are admirable, and even on an iron vessel the most improved modern compass can be trusted by the mariner almost as completely as the chronometer itself. Just as in the case of the chronometer, however, it would be foolish to neglect the opportunities of verification of the instrument which are constantly recurring on shipboard. Continually tested, and its performances brought frequently under review, it serves all the purposes of the seaman, and in foggy as well as in clear weather a captain can trust his compensated compass to navigate his ship.

The brief historical exposition of the development of the compass, which occupies forty pages, is singularly interesting. Founded as it is on the Admiralty Manual, it is reasonable to expect to find, as we do, that the immense work of English men of science should be justly appreciated, but it is not perhaps so much a matter of course that that appreciation should be as generous as it is just. The French scientific man cannot always realise that science may sometimes emanate from other centres than Paris. M. Collet is not less scrupulously just to people of other nations than a German *savant* would be, he is more generous, and his book is more readable.

OUR BOOK SHELF

Stanford's London Atlas of Universal Geography. Quarto Edition. (London: Stanford, 1882.)

THIS new atlas appears to us to be superior in many respects to the ordinary run of such works. There are forty-four maps, and the selection has been made with great judiciousness, and with a special view to adapt the atlas to an English public. Britain and her dependencies occupy a prominent position; Canada has three maps; besides Australia there is a beautiful map of Tasmania, another of New Zealand, and one of the Fiji Islands, a specially original feature. Ceylon, moreover, has a map all to itself. The two maps devoted to Turkestan are of obvious utility, and have evidently been done with great care. There is a specially good separate map of Switzerland. Of Britain, besides the general maps of each of the three kingdoms, we have a fine orographical map showing by difference of tint both the varying height of the land and the varying depths of the sea around our shores; and another map showing the distribution of the rainfall. There is a separate map of Japan, a very useful one of the Indian Archipelago, and a map of Africa in which several of the hitherto vaguely indicated Central States have had an approximate definition given to their areas. These are a few of the more prominent features of the atlas. The execution is on the whole thoroughly satisfactory; several of the maps, indeed, were originally by Arrowsmith. Appended is a copious index of places, with their latitude and longitude.

Farming for Pleasure and Profit. Eighth Section—Market Garden Husbandry for Farmers and General Cultivators. By William H. Ablett. (London: Chapman and Hall, Limited, 1881.)

That there is a certain amount of pleasure in farming culture as there is in every other occupation in life no one will deny, but whether the pleasure goes hand in hand with profit is another question. In these days of agricultural depression anything that can conduce to either pleasure or profit in farming would, we doubt not, be hailed by thousands; for farmers, however, to take up with market gardening in all its details as laid down by Mr. Ablett, would be to revolutionise the practice of farming as generally accepted, and to constitute themselves into market gardeners pure and simple, this the author seems to have considered impracticable, except in the neighbourhood of London or large towns where in the markets the produce can be quickly disposed of. To adopt a legal phrase we may say we do not think the author has made out a case for the more general adaptation of farm lands for market garden produce, because while fully believing that many of the more important vegetables might be cultivated on a much more extended scale, we do not see that the crops would be more profitable to the grower than those with which he is more accustomed, and which, instead of requiring an immediate sale, can be stored and disposed of at any time. But while many vegetables, more particularly root crops, as potatoes, carrots, parsnips, turnips, &c., may with profit be grown by farmers, we very much doubt whether mushrooms would be generally taken up or prove advantageous, and still less so the morell and truffle, all of which are included in Chap. X, the two latter of which the author says are not objects of cultivation in this country, a remark that is quite true, and therefore it does not form the slightest excuse for admitting even a notice of them into the book. Still less can any excuse be found for the occupation of three-quarters of a page by the Fly Agaric (*Agaricus muscarius*), a well-known poisonous species.

The final chapter of the book concludes with some remarks on flower growing, a branch of cultivation that would, we should think, seldom or never be united with that of farming proper. The book is well printed, and is freer from typographical errors than is usually the case; nevertheless there are errors in spelling that ought not to have occurred, such, for instance, as *Solanum tuberosam* for *S. tuberosum*, *Lepidum* for *Lepidium*, and *Cochlearia armorica* for *Cochlearia armoracia*. Notwithstanding that many other works exist which give full cultural details for growing market garden produce, we have no doubt that this latest production will be found of use to some growers.

The Land of the Morning; an Account of Japan and its People. By William Gray Dixon, M.A. (Edinburgh: James Gemmell, 1882.)

General works in Japan have increased so rapidly in recent years that the claims of every new writer on the subject may well be examined with attention. Those of Mr. Dixon are that he resided four years in Tokiô as Professor in the Engineering College there, that he travelled over nearly four thousand miles of the country, including many remote and mountainous districts, and that he was thrown into contact with representatives of all classes of Japanese society from Cabinet Ministers to peasants. To these may be added the further circumstance that really accurate and valuable books, such as those of Sir Edward Reed and Miss Bird, are somewhat expensive, while Mr. Dixon desired to furnish a moderate-sized volume at a moderate price. In this we think he has succeeded. "The Land of the Morning" is a handsome volume of nearly 700 pages, with numerous illustrations. When we examine the contents of the work, we find that they are in every way worthy of their handsome exterior. After a brief and apparently accurate sketch of Japanese history, and especially of the troubles which led to the revolution of 1868, Mr. Dixon describes new Japan, its institutions, and people. This he does with a sympathy which is all the more praiseworthy that it is the result of four years' close observation, and not the newly-developed ardour of a casual visitor. We turn with especial interest to Mr. Dixon's account of Japanese students. Many young men from Japan have shown themselves matches for brilliant European students, notwithstanding the initial obstacle which they have to overcome in acquiring the language; these, however, are clearly exceptions, and we therefore look to Mr. Dixon's experience for an account of the average Japanese student. He has devoted a whole chapter to the subject, and the picture is in some respects not a pleasant one.

Devotion to study, which frequently leads to overwork and permanent ill-health; attention and respect for the teacher; good-humour; an extraordinary development of memory; some originality, a high sense of honour and much gratitude, are all found in the average student; but with these we find a self-conceit which is ridiculous, a mind clear rather than deep, and a "narrow intellectualism" which blinds him to the necessity for moral as well as intellectual development. If there is a rapid development there is also a rapid decay. The picture, we believe, is a true, albeit somewhat melancholy one.

The popular idea that Japanese isolation, which was first rudely broken by the American Commodore Perry in 1853, was the result of hostility and prejudice towards foreigners, will receive a shock from Mr. Dixon's chapter on the subject. "The real cause," he says, "of Japan's exclusiveness was a fear that free intercourse with the outside world might lead her into subjection to some foreign power." Mr. Dixon is indignant that "an American gentleman of considerable fame in biology and cognate subjects"—Prof. Morse, of Salem, we believe—"instead of keeping within his own province," preached "atheistic evolution" in a temple at Asakusa in Tôkiô; in other words, lectured on evolution and the Darwinian theory, and founded among his students a biological society which is still active and vigorous. The really good work which Prof. Morse did for education and science in Japan cannot be dismissed by a few abusive epithets, and we cannot help thinking that Mr. Dixon would have acted more discreetly, and more in accordance with the general tone of the work, had he omitted references such as these. This, however, is but a minor blot in a work of such general excellence.

A Study of the History and Meaning of the Expression "Original Gravity." By J. A. Nettleton, of the Inland Revenue Laboratory, Somerset House. (London: A. Lampray, 1881).

This little treatise, the substance of which appeared in the *Brewers' Guardian*, has been compiled mainly for the information of brewers and distillers, and for the use of the officers in the Inland Revenue Department, in order to permit of the original gravity of a sample of wort of beer or of distillers' wash to be determined after fermentation with a view of fixing the amount of drawback, in conformity with the Act 10 Vict. cap. 5, 1847, and the Inland Revenue Act, 1880. There are four different methods in more or less common use for determining "original gravity." These are very fully described and the incidental errors carefully noted; preference is very properly given to the distillation process of Dobson and Phillips, with the modifications in the tables rendered necessary by the investigations of Graham, Hofmann, and Redwood, made at the instance of the Board of Inland Revenue. We can recommend the work as a thoroughly trustworthy guide to the brewer and distiller in a matter of great practical importance to their trades.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Hypothetical High Tides

WHATEVER conclusion may ultimately prevail with regard to the existence of very high tides in the earlier epochs of which geology has cognisance, I think that geologists will hardly accept the argument by Prof. Newberry, in your last issue (p. 357) as a settlement of the question. He appears to confound together three agents whose effects widely differ, viz.: (1) tidal waves of undulation, (2) tidal waves of translation, and (3) wind waves. In waves of undulation the particles of water move only in a vertical line, and can obviously neither denude nor transport. Waves of translation, acting as currents, are transporting agents, but are very subordinate to wind waves in their denuding power. In the present state of things waves of translation, *i.e.* the tides of our inland seas and estuaries, can hardly be said to denude at all; they simply shift mud and sand from place to place. Even if their speed were enormously increased, their effects, as denuding agents must still be very inferior to that of wind waves.

The picture which Prof. Newberry has drawn of an enormous current rushing round and round the globe, sweeping away continents, and destroying whole faunas, is not justified by fact. In the open ocean there would be no current at all due to tidal action, but simply, a vertical rise and fall. The Trilobites and Brachiopoda which swarmed in the Silurian seas would be conscious of no change in their surroundings save an alternate deepening and shallowing of the water over their heads. Where the tidal wave became inclosed between two lands its height would increase; but it would acquire no transporting power till it was filled up in narrow estuaries. Marine denudations would be mainly effected, as at the present day, by wind waves.

I will present Prof. Newberry with a more energetic denuding agent than his tidal wave, viz. wind waves originating in the more powerful air currents of a globe rotating at (perhaps) thrice its present speed. But what could such waves do which our present waves cannot do? They would simply work more rapidly. They would produce deposits of conglomerate, sand, and mud, which would in no respect differ from modern strata. There would be nothing in the nature of the sediments from which we could either affirm or deny the existence of a more potent engine of denudation.

Prof. Newberry attempts to show that the hypothetical tidal wave of Devonian times would prevent the formation of coral-reefs. But this argument proceeds on the assumption that the habits of the Devonian corals were identical with those of recent reef-building polypes. Since, however, the Palæozoic corals belong to extinct families, any inference as to their habits must be purely hypothetical. Besides, the tidal wave must have greatly diminished by the Silurian or Devonian epoch, and may not have exceeded the 150 or 200 feet which Mr. C. Darwin fixes for the limit below which the polypes cannot live.

Prof. Newberry makes a strong point of the evidences of quietude which we find in ancient littoral zones. The hypothetic tidal wave, he thinks, must have swept over the mollusks, corals, and sea-weeds which tenant the shore, so that they would be subject to the "greatest mechanical violence," and their zone would be rendered "uninhabitable." To this I reply (1) that shores bordering on the open sea would only be exposed to a wave of undulation, and (2) that even a rushing wave of translation would do less harm than our modern wind waves, which hammer against the shores where mollusks and sea-weeds manage to spend a tolerably peaceful life.

There are other details on which I should like to join issue with Prof. Newberry, but I fear to trespass upon your valuable space. C. CALLAWAY

Wellington, Salop, February 17

SURELY Mr. Newberry has too quickly come to the conclusion with which his paper of February 16 ("Hypothetical High Tides") terminates. I think if he reconsiders the matter he will still find that there is room for discussion. Has he fully taken into consideration the fact that at present, although in some places there are tides of thirty feet or more in height, notably where the waves roll in from the open ocean to some of the more or less confined bays or estuaries, on the contrary, in confined seas on the Mediterranean, Euxine, and Baltic, the tide is scarcely perceptible? This being the case, is it satisfactorily proved that the old Potsdam beach of which Mr. Newberry speaks was not deposited on the shore of such an inland sea, where, in despite of the fact that the oceanic tides might measure 200 feet or more, yet here I think the littoral zone might be comparatively quiet; at any rate sufficiently so to support both animal and plant life? I merely make this suggestion in the hope that somebody more able to deal with the subject than I am will continue the discussion. A. HALE

Filston Hall, Shoreham, Kent, February 20

Rime Cloud observed in a Balloon

UNDER this heading (NATURE, vol. xxv. p. 337) M. de Fonvielle made an interesting communication on a cloud suspended over Paris, through which he and M. Brissonet passed in a balloon on January 25 last. Its thickness did not exceed 300 metres. "The nebulous matter," he says, "appeared perfectly homogeneous, and I could see no trace of any crystalline matter, but an unexpected observation proved that it was formed of minute solidified atoms of water in a real microscopic state of division."

While the balloon was floating over the cloud the sky was clear, and the temperature of the air from $-2°$ to $-3°$ C., and a rope hung from the balloon, the length of which was 60 metres, its end being immersed in the cloud. "We perceived that this part was quite loaded with hoar-frost, which had precipitated regularly by series of hairs a few millimetres long,"

During the slow ascent no deposit of ice was visible; "in our descent, which was rather quicker, but not to a great degree, the sweeping may have accumulated the frost rime on the bottom of the car, which could not have been easy to observe, and consequently I cannot state what occurred, but not a single crystal was deposited on our ropes during that period."

The mean temperature of the cloud is said to have been 5° C., but at the point at which the deposition of rime took place the temperature must have been 0° or lower. The upper layer of the cloud might have been colder than the layers below.

It is improbable that the upper part of the cloud consisted of solid water, as no trace of any crystalline matter was visible. The smallest crystals of snow are visible in the air in the thin mists formed over channels of water, for the snow crystals glisten and reflect light from their exceedingly small surfaces. M. de Fonvielle must have observed this phenomenon, as "the sun was shining in its full glory." It is more probable that the cloud was formed by small drops of liquid water cooled below zero. We know from Dufour's observations that water-drops, if they are not in contact with solid matter, and floating in mixture of rock-oil and chloroform of equal density, may be cooled down to $-10°$ C., and even to $-20°$ C. if they are small enough, but become crystalline in contact with a solid body, especially a trace of ice. The hoar-frost which we have frequently noticed this winter in Heidelberg, during hazy weather, and when the temperature was below 0°, may have been due to the solidification of such drops of mist. It covered the plants first with filigree-like ice, and then with a thick crust of the same. In consequence of this, sometimes so much ice is deposited on the stems of the trees that great damage is caused by it in the forests; this was the case in the neighbouring "Rheinpfalz" in the winter 1858-59, and in other parts of Germany, especially in Bohemia.

It is, however, well known that a thick mist may consist of crystals of ice. Equally well known is Scoresby's description of the "frost-dam" or "frost-rime" of the Arctic regions, as it forms a layer in the cold air over the warmer sea-water, the masts of the ships projecting over it. Mohn describes the "Frostzög," which is formed in winter over the Norwegian fjords, which never freeze, when cold air, sometimes at a temperature of 20° C., and even lower, blows from the land over the water, which has a temperature above 0° C.

To these interesting occurrences of mist, generally termed ice-fog, one particularly interesting instance has been added by Hildebrand-Hildebrandsson's meteorological observations made during the voyage of the *Vega* (*Zeitschr. der Oesterr. Gesellsch. f.*

Meteorologie, 1881, xvi. 369; *Naturforscher*, 1882, No. 5.) During Baron Nordenskjöld's wintering near Pitlekaj, on the Cape Serze Kamen (near Behring Strait) in 1878-79, an ice-fog was formed by the north wind predominating there during the cold season, by which the aqueous vapour from Polynja was blown over the cold mainland. This ice-fog rendered the air opaque to such an extent that it was found necessary, in order to find the way, to span a rope from the ship to the observatory which was erected not far off on the shore.

Heidelberg, February 11 HERMANN KOPP

Earthquake in the Andaman Islands

I SEE among the Notes in your last issue (p. 325) that there has been widespread seismic disturbance in Asia, including Ceylon, but unfortunately in no instance is the date given, which would have added very greatly to the value of the record. It may be interesting to give an extract from a letter I have just received from my brother, Mr. Harold Godwin-Austen, from Port Blair, Andaman Islands, which very probably was connected with the disturbance in Ceylon, and if so, it covered a very considerable area of the earth's surface, the distance being about 750 miles between the two places:—"Port Blair, January 2.—We had a very bad earthquake here on December 31, 1881, at 7·52 a.m. I thought the place was going to pieces. There has been a good deal of damage done to work and pucca (brick) buildings, and we had five high and low tides in three hours after the shock, and the sea did not quiet down all day. Since then we have had two or three slight shocks."

Deepdale, Reigate, February 9 H. H. GODWIN AUSTEN

The "Overflow Bugs" in California

THE following experience from one of my correspondents, Mrs. A. E. Bush, of San José, California, is, I think, well worth publishing, as showing how Ground-beetles may be so numerous as to become a nuisance to man, the Carabidæ generally being indirectly beneficial to him by devouring plant-feeding species. The insect popularly denominated "Overflow Bug" in California is the *Platynus maculicollis*, Dej.

Washington, D.C. C. V. RILEY

"We lived in Fresno Co. two years, in the north-eastern part, and in the foot-hills of the Sierra Nevada. It is hot and dry there; no trees and many rocks where we were; thermometer ranging from 96° to 108° for about three months. In June and July, when hottest and driest, the "overflow bugs" filled the air between sunset and dark. You could not with safety open your mouth. They would light all over your clothes; they filled the house; they swarmed on the table, in the milk, sugar, flour, bread, and everywhere there was a crevice to get through. Take a garment from the wall, and you could shake out a cupfull. It was a veritable plague. In a shed where the boards had shrunk and the cracks been battened, the spaces between the shrunken boards were packed full. They were flying for about two weeks, and then they disappeared mostly or they did not fly much, but were hidden under papers, clothing, and every available place. In November, before the rains, they spread around, but not to fly; make a light in the night, and you would see the floor covered; lift up a rug, and the floor under would be black, and they would go scattering away for some other hiding-place. I had occasion to take up a floor board after they had apparently disappeared, except stragglers. The house was upon underpinning two feet or more from the ground. When the board was raised, there were the 'overflow bugs' piled up against a piece of underpinning, making such a pile as a half bushel of grain would make. They were all through the foot-hills the same, and much the same in Los Angeles, about Norfolk, but they did not fly much in the latter place. In Los Angelos they seemed to be worse before the 'Santa Annas,' a hot wind from the desert filling the air with sand; and though the chickens were ever so hungry for insects, they would not eat the 'overflow bugs.' In the night you put up your hand to brush one from your face, and then you get up for soap and water to cleanse your hand. In the morning, if you put on garments without shaking, you get them quickly off and shake them."

Solar Halo

WE were favoured here on the 16th inst. with a view of a rather unusual phenomenon. Shortly after 8 a.m., the sky being for the most part clear with detached masses of fleecy clouds towards the south, two mock suns appeared, one to the west very brilliant, the other rather fainter, and of a crimson shade at times. The halo was visible for a little distance near the western one, which, with the bar of light from the sun extending along the bank of cloud beyond, formed a perfect cross. They gradually waned, the eastern one, however, becoming once or twice more brilliant, till a little after 10, when the sky grew overcast and they disappeared. W. F. EVANS

Felsted, Essex

Auroral Display

AN auroral display was observed here last evening between 7h. and 8h. The sky was partially overcast during a portion of the time, but it cleared about 7h. 10m., when the northern quarter was lighted up by a bright glow of an aqua-marine line. Only three faint streamers were remarked They were of a creamy-white colour, and extended from the horizon in the direction of the magnetic north nearly to the zenith. Examining the auroral light with a direct-vision spectroscope by Hilger, I saw one remarkably distinct line, which was estimated to occupy the position of the characteristic line observed by Angström and others, between D and E. No other lines were visible.

Bedford, February 21 THOS. GWYN ELGER

A Plea for Jumbo

WILL you open your columns to a short but earnest plea for poor Jumbo, of the Zoological Gardens? No one can read the description of the attempts made to remove him without feeling that it would be a disgrace to English lovers of animals to let him be transported. To outsiders it is a mystery that Mr. Barnum should have succeeded in purchasing him, and if some means are not discovered of satisfying Mr. Barnum's claims without doing violence to the public sentiment of humanity, it will be a cause of indignation to many of us. You should hear my wife talk about the matter, but of course she is only a woman, she is certainly not a "Fellow." In this case, however, it is possible that her womanly instinct is worth more respect than the motives which have led to the sale and purchase of our favourite quadrupedal fellow-citizen. A. R.

THE CHEMISTRY OF THE ATLANTIC[1]

I.

IN this work are collected and discussed the results of the chemical investigations on the nature of the water of the North Atlantic, made during the Norwegian expeditions of the summers 1876, 1877, and 1878. The contents of the volume are divided into three chapters—I. On the Air in Sea Water; II. On the Carbonic Acid in Sea Water; and III. On the Amount of Salt in the Water of the Norwegian Sea. It is therefore wholly concerned with the chemistry of the water; chemical researches in other directions are promised for a future volume. Although the subject is thus restricted, there is abundant matter of the greatest interest both from a chemical and from a geographical point of view.

Apart from isolated experiments, the first occasion on which the gaseous contents of sea-water were the object of systematic and successful study was during the German expeditions to the Baltic and the North Sea in 1871 and 1872 in the *Pomerania*. In the *Lightning* and the *Porcupine* attempts had been made to examine the water in this direction, but the results were not satisfactory. In order to determine the gaseous contents of a sample of water it is necessary first to eliminate and separate the gas from the water, and then to analyse it; and these form two distinct operations—one, the former, of which can be carried out perfectly on board ship; the other requires the steadiness of a shore laboratory. On board the *Lightning* and the *Porcupine* the mistake was made of attempting the analysis as well as the extraction of the air on board.

[1] The Norwegian North Atlantic Expedition, 1876-78. Chemistry. By Hercules Tornøe. (Christiania: Grøndal and Son, 1880.)

Dr. Jacobsen, the chemist of the *Pomerania* Expedition, has the merit of being the first to have rendered practicable the carrying out of such operations as the extraction of the gases and the determination of the carbonic acid in sea-water at sea. In subsequent expeditions his apparatus has been used with but slight modifications. His apparatus for extracting the oxygen and nitrogen was used on board the *Challenger* and by Dr. Tornoe without alteration; the method of determining the carbonic acid was modified both on board the *Challenger* and on the Norwegian expedition.

In the first chapter, "On the Air in Sea Water," Dr. Tornoe describes the apparatus used for obtaining samples of the water at different depths. In principle it resembles most other instruments devised for the same purpose, consisting of a tube which is open at both ends while descending, thus allowing the water to pass freely through it. On reversing the motion, the two ends are closed by conical valves worked by screw fans. In construction, however, it differs widely from other instruments of the same kind. Instead of being straight the tube, which forms the body of the instrument, is spiral, and holds about five litres. The diameter of the tube is 5·5 centimetres, and the external diameter of the spiral is 33·5 cm., the total length of the instrument over all being 144 cm., or nearly 5 feet. These measurements are taken from the plate accompanying the book, and it is apparent from them that the instrument is one of very considerable size; it is a pity that its weight is not given. Both ends of the spiral tube have conical valve seats, the smallest diameter of which is equal to that of the tube. The valves fitting these apertures are kept open during descent by the action of screw-fans, which turn in one direction during descent; when the direction of the motion is reversed and the ascent commenced, the first few turns of the screw-fans are used for bringing the valves close to their seats, when, being released from the screws, they are pressed home by a pair of spiral springs. In order to do the necessary work on the screws, the instrument has to travel through about seven fathoms of water. The water, therefore, which it brings up will be a fair average sample of the particular seven fathoms through which it was drawn. The instrument appears to have given great satisfaction, and it has many good points in its construction. The spiral form of the tube is an ingenious contrivance for increasing its capacity without unduly lengthening the whole apparatus, but the spiral form also produces an increased resistance to the passage of the water, so that what passes through will lag behind what passes outside the instrument. Hence the sample actually inside the tube at any moment is a sample of the water a certain number of fathoms above it, and not of the water in the centre of which it is plunged. For ocean work this is not a serious drawback, and it is in a great measure corrected by the necessity for hauling it backwards through seven fathoms of water before it is closed. The arrangement for working the valves is very ingenious, and permits the use of several instruments on one line, for the instrument requires to traverse seven fathoms of water in order to close, and this is much more than would be traversed by it with the line held fast and exposed only to the rolling motion of the ship. This advantage, however, is rendered nugatory by the great size of the instrument, as one of them would be a sufficient load for any line. It is evident that for taking samples at small intervals of depth as every five fathoms, the instrument would have to be modified, or one of the other existing forms used; but for the collection of the samples which actually were taken, the instrument was quite satisfactory. Its inventor was Capt. C. Wille of the Norwegian navy.

The apparatus used for boiling out the gases is exactly that recommended and figured by Jacobsen in Liebig's *Annalen*, vol. 167, p. 1. It consists of three parts—*a*, the flask for the reception of the sea water to be boiled, its capacity is about 900 cub. centims.; *b*, the bulb tube, fitted into the mouth of the flask by an india-rubber cork, which, with the tube, forms a most ingenious kind of slide-valve, enabling connection between the flask and the remainder of the apparatus to be made or broken at will. This bulb-tube serves a double purpose: at first it contains a supply of distilled water, which, being converted into steam, drives all the air out of the upper part of the apparatus, and so enables a vacuum to be formed; in the latter part of the operation it serves for the reception of the sea water which expands into it out of the flask during the process of boiling. The third part of the apparatus, *c*, is the gas-tube in which the sample of gas is sealed up and preserved when it has been extracted from the water. This tube, which ought to have a capacity of about 60 or 70 cub. centims., resembles a pipette whose end-tubes are reduced to a length of 5 or 6 centimetres, and are contracted to a very small diameter near the body. It is attached to the bulb-tube by a piece of good india-rubber tubing, care being taken that the ends of the two tubes abut. By the boiling of the distilled water in the bulb-tube at the commencement of the operation all the air is expelled, and the apparatus hermetically closed by sealing up the gas-tube at the contraction at its upper end. During this operation communication is interrupted, by means of the slide-valve, between the flask and the bulb-tube. After the upper end of the gas-tube has been closed, communication is re-established, and the water in the flask now finds itself exposed to the action of a tolerably good vacuum, and in consequence the air dissolved in it immediately begins to be disengaged; this is assisted by heating in a water-bath. When it is judged that the air has all been expelled from the water, the flask is again isolated by means of the slide-valve, and the gas-tube sealed up at the lower contraction and preserved for analysis. As there is always some of the gas remaining in the bulb-tube, the space so occupied is measured and noted, so as to be taken into account in determining the total volume of gas per volume of water. The beautiful part of this apparatus is the slide-valve arrangement, which was invented by Dr. Behrens of Kiel. Otherwise the apparatus does not differ from that described by Bunsen, and used by him in Iceland. Had it, however, been necessary to use Bunsen's apparatus unmodified, it may safely be assumed that we should now have very few analyses of the air dissolved in sea water. It is Dr. Behrens' invention which renders the operation sufficiently easy to enable it to be carried out successfully as a matter of routine at sea.

There is another item in the construction of the instrument which, though apparently insignificant, is really of the utmost importance in insuring a successful result—it is the way in which the contraction in the two end tubes of the gas tube is made. The tubes supplied to the Norwegian Expedition seem to have been much the same as those supplied to the *Challenger*. Both came from Thuringia in Germany, and in the *Challenger* ones the contraction was formed by thickening up the tubes before the blowpipe, so that the external diameter was not diminished, while the internal diameter was reduced often beyond what was necessary. Now in attempting to close the tube with the blowpipe at one of these thickened contractions, the thin and comparatively wide tube on either side of the thick contraction is very apt to be heated up to softening point before the much more massive contraction has got even hot. In the inside of the tube, however, there is, even after the boiling, a much lower pressure than in the outside atmosphere; consequently, immediately the tube next the contraction gets soft, it falls in, and though the tube may be drawn out, and so appear for the moment to be satisfactorily closed, the point so formed never fails to crack on cooling. This is the reason of the deplorable loss of as much as 75 per cent. of the gas samples boiled out by Dr. Tornoe on his last voyage. A

similar experience was made with the first few samples boiled out on board the *Challenger*, but it was detected in time to prevent any serious loss Indeed from dust and particles of sawdust having got into the tubes, it was necessary in every case, before using a gas tube, to remove its end tubes, clean the body thoroughly, re-attach the end tubes, and *draw out* the thickened contraction. When so drawn out, there is not the same mass of glass to be heated, and the contracted part can be heated for itself without any danger of softening the wide part. There was no instance of a tube cracking after being sealed up with these precautions. In recent practice the writer has considerably modified and improved the apparatus for extracting gases from water on shipboard, but a description of the apparatus would here be out of place.

The figures representing the results of the analyses are necessarily affected by errors incident to the collection and the transvasing of the water and to the separation and analysis of the gas. The combined effect of these errors can be appreciated by the study of the following table, in which are collected the results of analyses made in duplicate. It is not stated whether on each occasion two separate and distinct samples were collected and treated separately, or, from the same sample of water, two portions were separately boiled, and thus two portions of gas obtained for analysis. Of the nine waters so treated four came from the surface, three from the bottom, and one from an intermediate depth of 300 fathoms.

Table of Duplicate Analyses

Station No.	Depth (fathoms).	O + N cc per litre.	Difference	Oxygen per cent.	Difference.
125	700 (Bottom)	20·5 20·0	0·5	33·0 33·6	0·6
162	795 (Bottom)	20·6 19·4	1·2	32·6 33·7	1·1
213	1760 (Bottom)	19·6 —	—	34·0 33·8	0·2
332	1149 (Bottom)	21·9 22·0	0·1	32·2 31·8	0·4
345	300 (Intermediate)	20·9 21·5	0·6	34·4 33·9	0·5
183	Surface	20·0 —	—	36·1 36·1	0·0
283	Surface	19·8 19·5	0·3	35·4 35·3	0·1
—	Surface	20·7 —	—	35·8 35·4	0·4
323	Surface	19·3 —	—	36·5 35·8	0·7

From this table we see that the mean difference in oxygen per cent. as found in the different analyses of the gas from the same water was 0·5. The differences in the total volume of nitrogen and oxygen per litre varied from 0·1 cc. to 1·2 cc.

Dr. Tornoe has collected at pp. 15 and 16 the results of his analyses of ninety-four samples of air extracted from water of various depths. Of these thirty-three are from surface water, eighteen from intermediate, and forty-three from bottom water. The last-mentioned are from a great variety of depths, ranging from 25 to 1760 fathoms. His results give us a very complete account of the state of aëration of the water of the "Norwegian Sea," or of that part of the ocean extending from the Faröe Islands northwards to Spitzbergen, having for the greatest part of its length the shores of Norway for its eastern boundary. The investigations were carried on between the middle of June and the middle of August, or during the height of summer, consequently the temperature of the surface water was never either very high or very low. In the table of results the temperature of the water is given. Of the surface waters examined the mean temperature was 6·6° C., the highest being 11·8°, and the lowest 0·5° C. If the total volume of the oxygen and nitrogen be taken to be 100, then the oxygen was found to vary between 33·7 and 36·7, mean 35·4. The absolute amounts of the gases varied with the temperature.

The results obtained by Jacobsen in the *Pomerania* showed a very remarkable agreement in the percentages of oxygen found in the surface water. The mean results of twenty-one observations were as follows:—Temperature 16·66° C., nitrogen 11·07 cc., oxygen 5·69 cc., together 16·76 cc. per litre, and oxygen percentage 33·93. The lowest oxygen percentage was 33·64, and the highest 34·14. From this it was concluded that the percentage of oxygen in sea water is practically invariable, as it is in the atmosphere. For the limited area explored by the *Pomerania* this is undoubtedly proved, but the area was comparatively small and the variations in conditions, especially temperature, insignificant. In the *Challenger*, waters subject to the most varied conditions of climate were treated for the extraction of the gases, and before leaving the work of the expedition, now more than four years ago, the writer had analysed a considerable number of the samples of gas so procured. The results of these analyses showed at once that Jacobsen's conclusion as to the ocean as a whole was not justified, while it held good with regard to limited areas. If we confine our attention to surface water, the highest percentage was 35·01 in the Antarctic Sea, and the lowest 32·35 in the Pacific, between Fiji and Torres Straits. This was however a very remarkable water, and should be excepted. The next lowest percentage was 32·82, so that in round figures the oxygen percentage varied between 33 and 35. As the cruise of the *Challenger* was chiefly in tropical regions, the surface water had usually a high temperature; but water of all temperatures was experimented on, and if the results are arranged in ascending order of temperature, the oxygen percentage is seen to decrease very regularly.

In waters of temperatures above 20° C. the percentages ranged between 32·82 and 33·33, the mean of nine such observations being 33·09. The mean of five observations between 12° and 20° is 34·22, the extremes being 33·52 and 34·66. We gather from the results of the three expeditions that the percentage of oxygen is less in warm water than in cold.

In order to judge of the degree of saturation of the waters Dr. Tornoe reports some interesting experiments on the absorptive power of sea water for the atmospheric gases at different temperatures. He experimented on four temperatures, namely, 0° C., 5°, 10°, and 15° C., and from the results so obtained he gives the following formulæ for the solubility of nitrogen and oxygen in sea water exposed to a current of air:—

$$N = 14·4 - 0·23t$$

and

$$O = 7·79 - 0·2t + 0·005t^2.$$

The formula for nitrogen agrees with the facts of his observations at the four temperatures: that for oxygen begins to fail at the highest temperature, 15° C., and is clearly inapplicable at temperatures above 15° C., for it gives a minimum of solubility at 20°, and at 40° C. this solubility is the same as at 0° C., and is increasing.

The analyses of the gas from surface water do not agree very well with the figures given by his nitrogen formula. Jacobsen's results are also higher than would be given by the formula, and the *Challenger* results considerably higher. The last are better represented by the formula—

$$N = 15·8 - 0·23t.$$

Dr. Tornoe notices that the oxygen found by him in surface water is considerably in excess of what would be

given by his formula, but as the formula is clearly inaccurate for temperatures above 10° C. it is premature to conclude, as he does, that the surface water is supersaturated with oxygen. J. Y. BUCHANAN

(*To be continued.*)

THE BOSTON SOCIETY OF NATURAL HISTORY, 1830-1880

THE Boston Society of Natural History was founded in 1830 by a few earnest men, and in 1880 it resolved to commemorate its fiftieth anniversary by the publication of an historical sketch of its origin and life, and of a special series of scientific memoirs. This resolution has been carried into effect by the issue of a splendid quarto volume of over 600 pages and 40 plates, the paper and typography of which is worthy of the Boston Press.

Very interesting is the account given of the early struggles and early successes of this now so well-known institution. Preceded by the Linnean Society of Boston (founded in 1814), which at first made rapid progress and then gradually fell away, it was duly constituted in May, 1830, with Thomas Nuttall as president. At this time, Mr. S. H. Scudder states, there was not in New England an institution devoted to the study of natural history; there was not a college, except Yale, where even the modern views of geology were taught. The few labourers in the field of natural science worked alone, without aid or encouragement, and were regarded as triflers by a busy public. To go through the records of its early days, however briefly, would take up too much of the space at our disposal.

Once started into existence, the Society found itself with the responsibility of a rapidly increasing museum; and the demands upon its pecuniary resources, even though an enormous amount of gratuitous service was rendered by the members, soon began to be very troublesome. Generous and wealthy members replenished the empty treasury, and after its first ten years' existence (1830-40) it found itself, after a hard pinch, just free from debt. In 1841 the publication of the *Journal* of the proceedings commenced. Louis Agassiz joined the Society in 1847. Dr. Amos Burney, its president, died the same year at Rome. In 1848 the members assembled in a new house in Mason Street, and the close of a second decade (1840-1850) found them just holding their own.

Already in 1855 it became evident that the new abode was becoming all too small for the collections; and now it was well for the Society that they found so good a friend in John C. Warren, for he largely assisted in procuring the means for purchasing the present accommodation, though another ten years (1850-60) passed away, and it was not until 1861 that Dr. William J. Walker presented the Society with the estate in Bulfinch Street, where the Society's fine museum and library now stands. The magnificent donation of 10,000 dollars from Mr. Jonathan Philips, the products of the sale of the house in Mason Street, with many generous subscriptions, enabled the Society to think of building on the site presented to them by Dr. Walker, but on consideration they found that they had not more than half the money amount required. In this emergency Dr. Walker came again to their aid, presenting them with a gift of 20,000 dollars, on condition that a further sum of like amount were raised. The year 1864 found the Society in its present handsome edifice (the building of which had cost 80,000 dollars) and trying to solve the problem of how to keep up so spacious a mansion on its comparatively small resources. With wondrous liberality Dr. Walker once more offered a donation of 20,000 dollars, on the condition that a like amount were subscribed by others, the whole to form a working capital to be funded. This became an accomplished fact in May, 1864, but this was not all, for on Dr. Walker's death in April, 1865, it was found that he had left by will a large fortune to the Society, and following this good example ere this fourth (1860-70) decade passed away, other liberal members had subscribed some 50,000 dollars to the capital of the Society, thus establishing the Institution on such a firm foundation as to secure its perpetuity as long as wisdom shall prevail in its Councils. Its property, besides the buildings with their inestimable contents, consisted of vested funds, amounting to 186,898·20 dollars, and a fair annual income from members.

The fifth decade, the celebrating of the close of which took place in April, 1880, was chiefly noted for the progress that was made in a scientific arrangement of the collections of the Society, under the custodianship of Mr. Hyatt; by the deaths (1874) of Louis Agassiz, about whose early career some very interesting facts are given, and (1874) of Jeffries Wyman, of whom there is a short biography, of Charles Pickering 1878), of C. F. Hartt (1868), and of T. M. Brewer (1880).

There is a very valuable account of the Teachers' School of Science, which seems in Boston to have attained a great success, and a summary of the general contents of the Museum. Very excellent portraits of Benjamin D. Greene, George B. Emerson, Amos Binney, J. C. Warren, Jeffries Wyman, and Thomas T. Bouvé, being the first six presidents of the Society, accompany this part of the volume and also a history of Dr. William J. Walker, and engravings of the portraits of A. A. Gould and Dr. Humphreys Storer.

The second portion of this fine memorial volume is devoted to the publication and illustration of a series of memoirs, of which we must be content with the bare enumeration of their titles. These are thirteen in number, and are profusely illustrated: N. S. Shaler, Propositions concerning the Classification of Lavas considered with Reference to the circumstances of their Extrusion; A. Hyatt, the Genesis and Evolution of the Species of Planorbis at Steinheim (ten plates and a map); S. H. Scudder, the Devonian Insects of New Brunswick, with a Note on the Geological Relations of the Fossil Insects from the Devonian of New Brunswick, by Dr. J. W. Dawson (one plate); W. G. Farlow, on the Gymnosporangia (Cedar Apples) of the United States (two plates); Theodore Lyman, on a New Structural Feature, hitherto unknown among Echinodermata, found in Deep Sea Ophiurans (two plates); W. K. Brooks, the Development of the Squid (*Loligo pealii*, Les.), three plates; A. S. Packard, jun., the Anatomy, Histology, and Embryology, of *Limulus polyphemus* (seven plates); Edward Burgess, Contributions to the Anatomy of *Danais archippus*, Fab. (two plates); Saml. F. Clarke, the Development of a Double-Headed Vertebrate (one plate); C. S. Minot, Studies on the Tongues of Birds and Reptiles (one plate); Edward S. Morse, on the Identity of the Ascending Process of the Astragalus in Birds with the Intermedium (one plate); Lucien Carr, on the Crania of New England Indians (two plates); William James, the Feeling of Effort.

THE PHYSIOGNOMY OF CONSUMPTION[1]

THE idea that a certain type of face indicates a tendency to certain diseases is not only widely diffused in the medical profession, but among the public at large, as is shown by the frequent occurrence of such phrases as "consumptive-looking," and "apoplectic-looking." With a view to ascertaining how far these generally-entertained ideas are true, and of substituting for mere personal impressions the test of exact and unprejudiced investigation, the authors of this paper have made a number of observations by the method of composite portraiture, already described by Mr. Galton in NATURE. The countenance which is supposed to indicate a tendency to phthisis or

[1] "An Inquiry into the Physiognomy of Phthisis, by the Method of Composite Portraiture." By Francis Galton, F.R.S., and F. A. Mahomed, M.D.

consumption, is one of the best marked and most commonly recognised. The authors have begun with this disease, and at present have limited themselves to it. A large number of portraits of phthisical patients were first taken, and were then grouped into composites, clinical facts being first taken as guides for grouping. Thus, cases of advanced disease were grouped first, but they gave no result beyond that of well-marked emaciation. Cases grouped according to the rapidity of their course also yielded no characteristic type, nor was anything very definite at first obtained from those in whom the hereditary taint was strong, but on further investigation this last group of hereditary cases was found to fall into two main divisions, not separated by any abrupt line of demarcation. In the first division the faces were broad, with coarse, blunted, and thickened features; while in the second the faces were thin, narrow, ovoid, with thin, softened, and narrow features. These two groups correspond to the two types well recognised by physicians as strumous and tubercular. On comparing the phthisical with non-phthisical cases, however, it was found that the percentage of narrow ovoids was almost exactly the same in the phthisical and non-phthisical patients. Although the authors do not say so, we may perhaps be justified in regarding these two types of face as possibly racial. Their results lend no countenance to the belief that any special type of face predominates among phthisical patients, nor to the generally entertained opinion that the narrow ovoid tubercular face is more common in phthisis than in other diseases. Whether it is more common than among the rest of the healthy population, they cannot at present say. In comparing composites, both of the broad faces and of the narrow ovoid faces in phthisical and non-phthisical patients, they found that in each case the phthisical patients presented a more delicate form of each type, with finer features, a lighter lower jaw, and an altogether narrower face. Although their conclusions seem to indicate that there is no foundation for the belief that persons possessing certain physical characteristics are especially liable to tubercular disease, yet it may hereafter be proved that some explanation of the doctrine may be found in the course of the disease when it attacks such persons.

Thus the delicately-organised individuals called "tubercular," and characterised by their "narrow ovoid" faces, have been compared with horses and cattle who have been what is called "over-bred"; such animals are described as having too much nerve and too little bone and muscle; they have no "staying power," and readily "knock up." So these delicately-formed individuals are less able to stand the strain of disease and are more liable to its attacks than their more robustly-built fellows. Again, if it be true, as frequently asserted, that those having the features called "strumous" probably inherit a more or less diluted syphilitic taint, it is not surprising that they should be especially liable to inflammatory changes of a low type, and that disease in them should be readily amenable to treatment, especially by mercury, a result commonly seen in the so-called "strumous" diseases of children and often in those of adults."

This paper opens quite a new field of inquiry which is of great interest, and is likely to lead to important practical results.

JOSEPH DECAISNE

By the somewhat unexpected death of Prof. Decaisne, one of the most familiar names disappears from the scientific world of France. Although so inseparably associated with Paris Decaisne was by birth a Belgian, having been born in Brussels in 1809. His brother, still living, rose to the position of Inspector-General of the Army Medical Service of Belgium. When quite a young man Joseph Decaisne entered the service of the Jardin des Plantes at Paris in the position of a gardener. The venerable institution with which for the rest of his life he was associated is very different from a mere pleasure-ground, and it would be a mistake to suppose that the starting-point in Decaisne's career implied anything more than rising from the lowest rank in an establishment which in every detail is nothing if not scientific. In 1840 he was attached to the Herbarium as *Aide naturaliste*, finally returning to the Garden as *Professeur de Culture* and Director in succession to Mirbel.

From Mirbel to the present day is, measured by the rate of progress in botanical science, a tolerably vast leap. Decaisne published his first paper in 1831, and the half century which has since elapsed covers our whole modern knowledge of the histology and morphology of plants. The familiar demonstrations of our biological class-rooms already seem a little hackneyed. Yet they deal with structures and phenomena which, when the distinguished botanist who was buried last week first began to work, were things undreamed of.

Decaisne at a very early period turned his attention to the serious study of algæ, and it is perhaps in connection with this group that he has left his most indelible mark in botanical history. In 1841 he showed once for all that the *Polyperes calcifères* of Lamouroux, were not merely *Algæ*, but that the affinities of the diverse types which they comprised could be determined with some certainty. This was a piece of work which may be compared in its way to Mr. Moseley's discovery of the alcyonarian structure of *Heliopora*. The conclusion to which he arrived was not a happy guess, but was based on a laborious examination of the whole class of *Algæ*, with the object of arranging their chaotic assemblage on a basis approaching as nearly as possible to a natural classification. The results are given in an elaborate paper published in 1842. The divisions proposed are not essentially very different from those which are generally accepted at the present day. And they were really more natural than the subsequent but far more artificial classification proposed by Harvey, which has long held its ground in this country. In this particular line Decaisne himself did little more. But in scientific history a man's true position and influence is often most inadequately measured by the actual bulk of his published papers. Decaisne really founded the French School of Algology, the results of which will always be the fundamental memoirs in this branch of morphology. In 1839 Thuret came to Paris, and received from Decaisne instruction in the rudiments of botany. A master will generally infect a competent pupil with his own special enthusiasm, and it is easy to read the secret of Thuret's own splendid scientific career. Decaisne and Thuret began to work together on *Fucus*, which they procured from the fish market of Paris. They soon found, however, it necessary to visit the coast to carry on their observations, the result of which was published in 1844, in a joint paper, in which they first accurately described the antherozoids, assigning them their true function, and gave an account of the beautiful process of division of the primary oosphere in some of the species. After Decaisne's appointment to the direction of the Jardin des Plantes, Thuret carried on his algological work for a time alone, ultimately associating himself with Dr. Bornet, who is happily still living, and occupied with the gradual publication of their joint and classical work.

From the time of Decaisne's appointment to the direction of the Jardin des Plantes he in fact devoted himself heart and soul with scrupulous conscientiousness to the field of work assigned to him. The Jardin des Plantes deals not merely with plants in their feral, but also in their cultivated state. The mere routine duties of his post were onerous beyond belief. The occupants of French administrative scientific posts have no sinecure. They are at the beck and call of the State in all that relates to their subject, and no small

farmer in France in doubt as to the name of a pear, or how to manage an intractable graft would hesitate to apply to the *Professeur de Culture* on the subject. It was curious to turn from the bustle of the Parisian streets into the country-town like repose of the Rue Cuvier, where Decaisne was almost always to be found at work in his small red-tiled study lined with books, and ever delighted with urbane and old-fashioned courtesy to do the honours of the establishment. In the work of his latter life there was little room for epoch-making discovery. But his splendid "Jardin Fruitier du Muséum" is a monument of patient labour on the cultivated forms of fruit-plants elaborated in the thorough spirit of the naturalist; and its value will, in a scientific point of view gain with time when the races figured and described in it are supplanted and lost. Students of the future will turn to Decaisne's laborious pages to compare the stages of variation which he has permanently recorded. In much other work of this class he had the collaboration of his friend Naudin, now director of the botanical station at Thuret's country seat at Antibes, which his heirs presented to the French Government.

In the other side of the work of the Jardin des Plantes Decaisne was no less industrious. With minute scrupulosity he was always occupied with the elaboration of careful descriptions of new and interesting genera and species of plants, and the pages of his great "Traité générale de Botanique" (published with Le Maout, but of which the great bulk is based on Decaisne's life-long studies), are everywhere enriched with the results of his dissections. Of the first edition of this admirable survey of the vegetable kingdom an English translation by the late Mrs. Hooker, edited by Sir Joseph Hooker, was published in this country. He published at frequent intervals through his long life much excellent systematic work of a more detailed kind.

Decaisne's turn of mind was essentially precise and matter-of-fact. Perhaps for this reason the doctrines of evolution which in England and in Germany have given a new impulse to biological study, had little interest for him. He would triumphantly show crops of a cruciferous plant raised in front of the physiological laboratory under wire-gauze for many successive years. "There is no departure," he would say, "so far from the specific type," and beyond this kind of evidence he did not seem to care to go. Not that his mind was wanting in flexibility to new ideas; he warmly supported the investigations made by Bornet in confirmation of Schwendener's theory as to the nature of lichens—a subject on which most persons accustomed to the view that they are autonomous organisms, feel almost as strongly as if they were possessors of a vested interest menaced by Act of Parliament.

Decaisne was long associated with Brongniart in editing the botanical series of the *Annales des Sciences Naturelles*, and on his death became sole editor. In 1877 he was elected a Foreign Member of the Royal Society. He was unmarried, and to his devoted friend Bornet fell the melancholy lot of watching his last moments and closing his eyes.

W. T. THISELTON DYER

ILLUSTRATIONS OF NEW OR RARE ANIMALS IN THE ZOOLOGICAL SOCIETY'S LIVING COLLECTION[1]

VI.

14. THE GORAL (*Nemorhœdus goral*).—The "Goral," or "Gooral" of the Himalayan sportsmen is one of the groups of Goat-like or "Mountain" Antelopes, of which we have previously had an example in the Japanese Goat-Antelope (*Capricornis crispa*) figured in a previous article (NATURE, vol. xxiii. p. 488), but is slightly divergent in form, and in some respects perhaps more nearly allied to our familiar Chamois of the Alps and Apennines. In its general habit, as Dr. Jerdon tells us, the Goral is very caprine in appearance; the back is somewhat arched, and the limbs are stout and moderately long, which renders it well adapted both for climbing and jumping. The Goral inhabits the whole range of Himalayas from Bhotan and Sikim to Kashmir, at a range varying from a little above 3000 to nearly 8000 feet, though most common at about 5000 or 6000 feet. It is also found in the Sewalik Hills. According to Capt. Kinloch it is the least wild of all the Himalayan game-animals, and may often be seen in the immediate neighbourhood of the large hill-stations of Simla, Mussourie, and Nynee Tal. Its favourite haunts, we are told by the same distinguished sportsman, are the valleys of the Ganges and the Jumna and their tributaries; in the province of Chamba, north of Sikim, they are said to be particularly numerous.

Gorals in their native wilds are not truly gregarious, but are either met with in small parties of three or four, or in pairs. Their special resorts are steep rocky hills thinly sprinkled with forest, where they lie concealed in the daytime, and come out to feed in the morning and evening. Where the ground is much broken, Capt. Kinloch informs us, they are not difficult to stalk, and when at all plentiful afford good sport, and are capital objects of pursuit to the young sportsmen who may not be up to the "*grande chasse*" of the Himalayan Ibex.

Our figure (Fig. 14) represents a young male of this species, which was received from Calcutta by the Zoological Society in March, 1881, and is the first Goral that has been exhibited in their gardens.

15. The Burrhel Sheep (*Ovis burrhel*).—The various species of wild sheep are widely distributed over the mountain-chains of the Palæarctic region, one only—the Big-horn of the Rocky Mountains—being found in America. In Europe the only Sheep now existing in a wild state is confined to the islands of Sardinia and Corsica, where the Moufflon (*Ovis musimon*) occurs under two slightly different forms. But in our new possession of Cyprus a second species (*Ovis cyprius*) occurs and a closely allied form (*O. gmelini*) is found in the mountains of Asia Minor. The various mountain-groups of Central Asia are tenanted each by its own species of wild sheep (*Ovis karelini*, *O. poli*, *O. argali*, &c.), in some of which the horns attain a prodigious development, and, in order to render them able to support such a burden, the animals themselves are necessarily of enormous size and strength. In Kamschatka the representative of the sheep is the fine *O. nivicola* of Eschscholtz, discovered during Kotzebue's second expedition, which, as might have been naturally expected, comes nearest to the American "Bighorn."

On the confines of India four or five species of wild sheep come within the grasp of the collector and sportsman, though the genus has in fact nothing to do with the true Indian fauna. One of these (*Ovis cycloceros*) is an inhabitant of the Salt-range of the Punjab It is replaced in Afghanistan by the recently described *O. blanfordi*, and in Cashmere by Vigne's wild sheep (*O. vignei*). On the main chain of the Himalayas two fine species of wild sheep attract the attention of our sporting fellow-countrymen whose destinies take them to India. One of these, commonly called the Ammon, though not strictly entitled to that appellation,[1] is confined to the undulating highlands of Tibet, the other, although also an inhabitant of lofty ranges, occurs in many parts of the southern slopes of the Himalayas. This is the Burrhel, or Nahoor (*Ovis burrhel*), of which we now give a figure (Fig. 15), from two young examples recently added to the Zoological Society's collection.

The Burrhel, or blue wild sheep, Dr. Jerdon tells us,

[1] Continued from p. 298.

[1] The *Ovis ammon* of Linnæus is the same as *O. argali*: the proper name for the Himalayan "Ammon" seems to be *O. hodgsoni*, Blyth.

is found from Sikim nearly to Simla, but does not extend further west than the valley of the Sutlej, its place being there taken by *Ovis vignei*. The Burrhel is found on this side of the great snowy range at the head of the Tonse River, in the Buspa Valley, near the source of the Ganges, and still more abundantly eastward in Kumaon and Gurhwal, in the ranges between the Pindar and Bhagirutty rivers. It occurs only at great elevations,

FIG. 14.—The Goral.

from the limits of forest to the extreme limits upwards of vegetation, in summer generally keeping to the tops of the hills, and even in winter rarely descending below the forests.

In a state of nature the Burrhel prefers grassy slopes to rocky ground, and associates in flocks of various sizes, from four or five, to fifty, or even a hundred.

Capt. Kinloch, in his excellent account of the "Game

FIG. 15.—The Burrhel Sheep.

Animals of Tibet and the North-West," tells us that the best Burrhel-shooting is to be obtained in the Valley of Leptel, beyond the Millum Pass, and that of Spiti between the Manerung and Parungla Passes, and gives us an exciting account of his adventures in pursuit of these splendid animals in the former locality.

16. The Esquerzo (*Ceratophrys ornata*).—The glass cases which held the various species of insects in the

Zoological Society's Insect-house during the past summer have been partially devoted during the winter months to the use of small reptiles and batrachians, for which they seem to be in every respect well adapted. Most of these animals, although shy and retiring in their habits, enjoy the warmth of the sun's rays and thrive excellently in their new habitations.

Amongst the batrachians thus exhibited are several species of gigantic size when compared with their puny representatives in this country, such as the Agua Toad (*Bufo agua*) of Brazil and the Ocellated Bladder-Frog (*Cystignathus ocellatus*) of Buenos Ayres. But by far the most remarkable of these forms in the series is the Adorned Ceratophrys, or "Esquerzo" of the natives of the Argentine Republic—a large toad of brilliant colours and extraordinary form, of which a figure (Fig 16) is now given, taken from a water-colour sketch prepared by Mr. Ernest Griset.

The Esquerzo was discovered by Mr. Darwin during the celebrated voyage of H.M.S. *Beagle*, and first described by the late Prof. Bell in the "Zoology of the Voyage of the *Beagle*." This monster inhabits the pampas of Buenos Ayres, and is said to feed chiefly on its smaller brethren of the same class. Mr. Ernest William White, F.Z.S., to whom the Society is indebted for one of the two specimens now in the Gardens,

Fig. 16.—The Esquerzo, or Barking Toad.

specially mentions it in his lately-published "Cameos from the Silver-Land" as one of the characteristic forms of the grassy plains of the Argentine Republic. "In the damp grass," he says, may often be perceived the leering eyes and mottled black and green body of the huge Esquerzo (*Ceratophrys ornata*), whose gaping mouth crammed with the body of an unfortunate sapo (toad), and surmounted by threatening horns, inspires terror. This said Esquerzo bears an awfully spiteful character, and is credited with the deaths of many children. His appearance is certainly against him, but he is otherwise perfectly harmless."

The Esquerzo seems to thrive equally well on English frogs as on the toads of Buenos Ayres, and does well in captivity. It is not, however, a very good object of exhibition, as, if left to its own devices, it hollows out a cavity to fit its body into the turf with which it is supplied, and leaves only the top of its head and projecting eyebrows barely visible. If harried out of its retreat for the examination of some curious visitor, it expands its body into almost a circular shape, and bites fiercely at any small object presented to it. At the same time it gives vent to its injured feelings in an angry whine, something like the snarl of a puppy, which has caused it to be known amongst the frequenters of the Gardens as the "Barking Toad."

NOTES

We are glad to notice that a decided step has been taken towards the preservation of our ancient monuments. Sir John Lubbock has succeeded in getting the following resolution adopted in the House of Commons:—"That pending the introduction of a general measure dealing with the ancient monuments of the kingdom, and in order as far as possible to protect them from further injury, it is desirable that Her Majesty's Government should appoint one or more inspectors with authority to inspect and report upon such ancient monuments." Mr. Shaw-Lefevre, on the part of the Government, assented to the motion, and added that it was their intention to bring in a Bill dealing with the subject in which the hon. baronet took so much interest. Thus Sir John Lubbock's determined perseverance in this important matter is likely at last to meet its reward.

In deference to the strong feeling which evidently exists on the matter, the Zoological Society may be induced, if not too late, to reconsider the bargain they have made with Mr. Barnum for the disposal of their great African elephant, Jumbo, the universal pet of children. He has, we understand, been sold for 2000*l*., but has shown so obstinate and touching a determination not to leave the Gardens which have been his home since a baby that it seems cruel to force him to do so. The general feeling is expressed in a letter which we print to-day, and during the last few days there have been numerous remonstrances on the subject in the press; one correspondent suggests that if

the Society is really in want of the money, the public would be only too glad to raise it to keep Jumbo. One reason given for parting with the animal is the uncertainty of his temper; but we doubt if there is any real ground for this excuse, and we hope it is not too late to prevent the children breaking their hearts for the loss of their favourite.

In vol. xxiii. p. 561, we gave an illustration of the new Etna Observatory, and stated that it would probably be completed by 1882. Signor V. Tedeschi writes from Catania to the *Daily News* that the Observatory has just been finished. Signor Tedeschi points out the exceptional advantages possessed by the Observatory from its lofty position for astronomical and spectroscopical observations. "These advantages," he states, "induced the Municipality of Catania, at whose expense the observatory was constructed, to aim at its being an international station, and so they added to the observatory three large bedrooms, a dining-room, and kitchen for the use of such foreign men of science as desire to remain there for some time, and the telescope is furnished with a movable iron tube, the length and aperture of which can be modified at pleasure, so that foreign astronomers can apply the instruments they bring with them. The observatory is built on a little eminence on the side of the central crater of Etna, a position which makes it almost certain that should a stream of lava issue on that side it would divide into two streams and flow harmlessly on each side of the little hill. The building consists of two storeys, the joint height of which is 9 metres, and the base of the edifice occupies a superficial area of 200 square metres. In each storey there is a large circular room surrounded by other chambers destined for different uses. In the centre of the circular room in the lower storey there is a solid pillar to support the great refractor. All the instruments, as well as a fine collection of seismographic and meteorological apparatus are in the upper storey, in the large circular room of which are the telescope and chronometrical apparatus. This room is roofed with a movable iron dome. The observatory on Etna is the highest building in Europe. The observatory on Vesuvius is 619 metres above the level of the sea, the Hospice of the Gotthardt 2075 metres, and that of St. Bernard 2491; while the Etna observatory is at a height of 2942 metres." This observatory will probably render invaluable service to astronomical science as well as to terrestrial physics.

Natal, we are glad to learn, is going to have an observatory, as will be seen from the following extract from a Grahamstown paper:—"Through the generosity of three well-to-do colonists in Durban we are going to have an observatory at Natal at last. It seems that Mr. Gill, the Astronomer-Royal at the Cape, is now on a visit to the port, and noticing that Durban is a favourable site for observing the transit of Venus, he mentioned the circumstance to Mr. Henry Escombe, who at once offered to give a first-rate equatorial telescope, costing 450*l*. The Town Council granted a site for the observatory, and Mr. W. Randles and Mr. Greenacre, two Durban merchants, undertook to defray the cost of the building (300*l*. to 400*l*.) between them." A correspondent of the *Scotsman* commends this excellent example to the shipowners and landowners of Scotland, whose interests would be specially served by a well-equipped observatory on Ben Nevis.

Nine lectures on the Anatomy, Physiology, and Zoology of the Edentata will be delivered in the theatre of the Royal College of Surgeons, on Mondays, Wednesdays, and Fridays, at 4 o'clock, commencing on Monday, February 27, by Prof. W. H. Flower, LL.D., F.R.C.S. The following is a programme of the course:—General characters of the order: Family *Bradypodidæ*—the Sloths; *Megatherium* and other great extinct Ground Sloths of America; Family *Myrmecophagidæ*—the true Anteaters; Family *Dasypodidæ*—the Armadillos; *Glyptodon*—and other extinct Armadillo-like animals; Family *Manidæ*—the Pangolins or Scaly Anteaters or Aard-varks; the extinct Edentata of the Old World; Classification of Edentata and relation to other groups.

In connection with the International Electric Exhibition at the Crystal Palace, arrangements have been made with Prof. S. P. Thompson, of University College, Bristol, to give the following course of lectures:—1. Electric Currents—What are they? (February 22); 2. Electric Currents—How to make them by Steam? (March 1); 3. Electric Arc Lights (March 8); 4. Electric Incandescent Lamps (March 15), on each evening at 8 p.m. The lectures will be illustrated by diagrams in the magic lantern, by experiments on a large scale, and by experiments in the magic lantern. This is a praiseworthy step on the part of the directors, and we hope it will meet with encouragement.

At the meeting of the Essex Field Club, to be held at Buckhurst Hill, next Saturday, February 25, the desirability of directing public attention to the pressing necessity which exists that some means should be adopted for the protection of our native animals and birds from wanton destruction by gamekeepers and others, will be brought before the Club by Sir Fowell Buxton, Bart. (Verderer of Epping Forest). Zoologists and lovers of Nature generally, whether Members of the Society or not, are earnestly requested to attend, and take part in the discussion.

One of the most recent additions to Chinese literature, according to the *China Review*, is a translation of Gray's well-known work on Anatomy. The translator, the late Dr. Osgood, is said to have succeeded in the task of giving Chinese names to the multifarious and minute structures which constitute the human body. The difficulty of this will be obvious, when it is remembered that the Chinese know hardly anything of anatomy, or of the functions of the various organs of the body. The only work up to this in Chinese on the subject was a very elementary one, published nearly twenty years ago, by a European physician.

A chain of meridian distances, extending from Vladivostok to Madras, has been telegraphically measured during the past year by Lieut.-Commanders Green and Davis, and Lieut. Norris of the U.S. Navy. The stations occupied and determined were Vladivostok, Nagasaki, Yokohama, Shanghai, Amoy, Hongkong, Manila, Saigon, Singapore, and Madras. The exact longitudes of the two terminal stations had been previously established by Russian and English officers, but the positions of the intermediate stations from which nearly all the longitudes of China and Japan have been chronometrically measured have always been seriously in doubt.

Attention continues to be bestowed on the search for new elements, and the classification of those which have been recently discovered. According to Phipson (*Compt. rendus*, xciii. 317), a specimen of zinc pigment examined by him contained about 4 per cent. of a new metal, to which, because of the action of light upon its salts, he gives the name *Actinium*. Mendelejeff (*Berichte*, xiv. 2821) shows that the recently discovered cerite metal Ytterbium finds its natural place in his scheme of classifying the elements according to their atomic weights. Two new chlorides of Gallium are described by L. de Boisbaudran (*Compt. rend.* xciii. 294), and determinations of the density of the vapour of gallic chloride have confirmed the number 69.9 as the atomic weight of Gallium.

Chemists are now paying much attention to the study of chemical changes, and they are beginning to venture on a few generalisations. Several Russian chemists have recently made important advances, notably Kajander, who considers the velocity of the changes which proceed when metals are dissolved

by various acids (*Berichte*, xiv. 2666), and finds that the rate of solution varies, according to the strength of acid, in the same way as the electric conductivity of the acid varies. Menschutkin (*J. Pract. Chem.*, xxiv. 49) continues his researches into the rate of etherification of various alcohols, and succeeds in tracing definite connections between this rate and the "molecular structure" of the various alcohols examined. Tribe (*Chem. News*, xliv. 185) attempts to measure the relative affinities between the constituents of electrolytes, by determining the magnitudes of the spaces between the boundaries of electro-deposits on metallic plates.

No. 2, Segundo anno (1 Fev. 1882), of the *Revista da Sociedade de Instrucção do Porto* (published at Oporto) commences with the first instalment of a "Catalogue des Insectes du Portugal," by Prof. M. P. d'Oliveira of Coimbra, printed in French. The somewhat lengthy introduction brings to light the existence in Portugal of more entomologists than most of us suspected, according to the list of persons thanked by the author for the assistance they have rendered him. The *Coleoptera* are commenced, but do not at present extend beyond the genus *Omophron* in the *Carabidæ*.

The temperature of the southern hemisphere has lately been investigated by Dr. Hann with the aid of recent observations of temperature in high southern latitudes, especially those made during the Venus transit in 1874. For mean temperature of the whole hemisphere he obtains 15°·4 C., and as that of the northern hemisphere was estimated by Ferrel to be 15°·3 C., it is very probable that both hemispheres have the same mean temperature. Dr. Hann, however, also shows that between 40° and 45° south latitude the southern hemisphere becomes warmer than the northern in the same latitude, and that a difference between the two persists at least to the confines of the hypothetical antarctic continent. The results of the projected antarctic scientific expedition this year, which will include a whole year's meteorological and magnetic observations in high latitudes, will do much, doubtless, to clear up the subject of temperatures. Dr. Hann urges the usefulness of a careful determination of ground-temperatures on islands (McDonald's Islands, Auckland, Maquarie, South Orkney, &c.).

Prof. Heim, of Zurich, has visited Fettan, the village in the Grisons which is being swallowed up by the ancient moraine on which it is built. He ascribes the phenomenon to the movement of underground waters, and considers that the perils may be averted by certain engineering operations, which will probably be executed under his superintendence.

Prof. Naudin has observed a lowering of the level of the Mediterranean at Antibes (Alpes maritimes) which amounts to 30 centimetres. He believes the reason to be the rising of the coast through volcanic influences. The inhabitants of the coast ascribe the phenomenon to the recent prolonged dry weather. Dr. Faye of Paris has also studied the subject, and according to his opinion it is the recent high atmospheric pressure which causes the recession of the sea in that locality.

Dr. Max Buchner, the explorer of the Lunda district, West Africa, has reported on his recent journey to the Berlin "Gesellschaft für Erdkunde." On December 10, 1878, he had started on his journey from St. Paul de Loanda to Malange (lat. 9° 32′ S., long. 16° 38′ E.). There he waited for the dry season, and by the end of July, 1879, he continued his journey with a caravan numbering 160 people. Without much trouble he passed through the land of the Songo, crossed the Quango and numerous other rivers, and penetrated to the residence of the Kioko chief, Mona Kissenge, who took him to be a merchant and wanted to stop him. Dr. Buchner managed to overcome all hindrance, and reached Kabongo (lat. 9° 30′ S., long. 21° E.), entering Mussumba, the residence of Muati Yambo, the Lunda chief, on December 11, 1879. Mussumba numbers 2000 inhabitants, and is the Eldorado of the slave trade. Muati Yambo and Queen Lukukesse, who reigns independently, received Dr. Buchner in solemn audience, but as the chief also believed him to be a merchant, he did not permit the traveller to proceed further into districts whence he himself purchases slaves and ivory, in which he does a large trade. Dr. Buchner remained at Mussumba for six months and then pretended to return. Near the Kassai River he turned to the north in order to penetrate into the unknown districts by the land of the Tukungo. This attempt however failed. Two other attempts to reach Kilua (Muata Kumpana's residence) also failed through the positive resistance of the inhabitants, and the mutiny of his guides and carriers. Thus he was compelled to return to Malansh.

The deaths are announced of M. Antoine Alexandre Brutus Bussy, member of the Academy of Sciences, an eminent chemist and physicist, at Marseilles, on February 4, aged eighty-eight; of Dr. Franz Schlegel, director of the Breslau Zoological Gardens, on February 7; of Frederick Warrington of Tripoli, who for over fifty years hospitably received and liberally assisted all African travellers who started from Tripoli for the interior, on January 26, aged seventy-four; of Herr Blasius Kleciak, a "Commisar" on the Dalmatian island of Lesina, and well-known as a conchologist, on January 12 last; of Dr. Simon Syrski, Professor of Zoology at Lemberg University, an eminent ichthyologist, on January 14, aged fifty-one; of Dr. F. J. Stamkart, formerly Professor at the Polytechnical School of Delft, Holland, an eminent mathematician, who died recently at Delft, aged seventy-seven; of M. Felix Billet, Dean of Dijon University, corresponding member of the Academy of Sciences, and author of numerous physical works and treatises, who died at Dijon on January 29, aged seventy-four.

A company has been formed at Palermo with the object of constructing a railway to the summit of Mount Etna, in imitation of the Vesuvius Railway.

The International Polar Commission has issued the first number of a special publication, edited by the President, Dr. Wild, to appear in regular numbers, for the purpose of insuring the rapid and continuous dissemination of intelligence relating to the International Polar Expedition. This number gives a sketch of the history of the scheme, the programme of observation, and a brief statement of what has been done.

The German Government has appointed a Commission consisting of Prof. Neumayer, Capt. von Schleinitz, Drs. Nachtigal, Dörgens, and Ernst Hermann, with the object of making the necessary preparations for erecting the German Meteorological station in the North Polar Region in conjunction with the other States participating in the International Polar Research recently planned. The Commission will meet at Hamburg during the present month.

Preparations for a North Polar Expedition which is to start during the present year are being actively made in Holland. The lead is taken by Prof. Buys Ballot of Utrecht. The Second Chamber has granted a subsidy of 30,000 florins, and a committee has been formed at Utrecht which intends to raise the additional funds that are necessary by means of public subscriptions.

The Russian Geographical Society have resolved to fit out an exploring expedition to Novaya Zemlya, and to give the command to Andreieff.

The first annual general meeting of the London Sanitary Protection Association is fixed for Saturday next. Prof. Huxley and Prof. Fleeming Jenkin will speak on the progress of the

Association, also Dr. Acland, Dr. Andrew Clark, Dr. Lauder Brunton, &c. It seems that of the 192 members of the Association 22 are medical men.

WE see from a report in the *British Guiana Colonist*, that the Museum in Georgetown, belonging to the Royal Agricultural and Commercial Society, is making excellent progress. Mr. Im Thurn, who has already done good work for science in the Colony, has returned to take charge of the Museum, and the reforms he proposes to introduce, with the approval of the Society, promise to make the Museum one of real scientific value, as well as of practical importance in connection with the development of the resources and industry of the Colony. Mr. Im Thurn is authorised by the Society to bring out a skilled German taxidermist, so that in time the Museum will probably have a valuable collection of birds.

THE Italian Government has published some interesting facts relating to the state of the public instruction in that country. The recent law on primary schools has been applied to 7533 communes of the 8276 existing in the Peninsula and surrounding islands. The number of public teachers in these schools is 41,000, viz. 20,700 males and 20,300 females. Out of a population of 26,801,194 the pupils are 1,048,000 males and 853,429 females, for a yearly expense of 31,000,000 francs—26,000,000 for wages and 5,000,000 for *matériel*. There are besides 7422 private primary schools with 7422 male and 4444 female teachers, but with 92,228 female and only 63,000 male pupils. There are also in the kingdom 11,161 male evening schools for adults and 472 female, the first with 439,624 pupils, and the other with 16,063. Females largely preponderate in Sunday schools; there are only 592 schools and 21,914 pupils for male Sunday instruction, and 5979 with 191,245 for females.

EARTHQUAKES in the northern alluvial districts of Europe are certainly of rare occurrence. Reports from many localities, however, prove that an earthquake was observed in North Schleswig and South Jutland on Jan. 14, between 10 and 11 p.m. The phenomenon was observed at Hadersleben, Kolding, Klitland, Ringkjöbing, &c. Early in January numerous shocks were observed upon the island of Chios. The western part of the island continues sinking deeper and deeper, so that its disappearance below sea level is shortly expected.

M. UJFALVY has returned from his journey to the Western Himalaya district, undertaken under the auspices of the French Government. This was the fourth scientific expedition undertaken by M. Ujfalvy. He again brings large ethnographical collections, also numerous anthropological specimens, skulls, samples of hair, and measurements.

FROM the programme of the Second German "Geographentag," to be held in Halle on April 12-14, an interesting meeting may be expected. The papers which are to be read are all on subjects of scientific interest, and afford one more proof of the highly scientific conception which Germans have of Geography.

THE "Handbook of Cinchona Culture," by Karl Wessel van Gorkom, formerly Director of the Government Cinchona Plantations in Java, has been translated by Mr. B. D. Jackson, Botanical Secretary of the Linnean Society of London, and will be shortly published by Trübner and Co.

CONFLAGRATIONS have at all times been the plague of Japanese towns. It has been said that Tokio, the capital of Japan, is rebuilt once in every seven years. During the winter of 1880-81 it was calculated that three-tenths of the city was destroyed by fire. Almost the whole commercial quarter, situated in the heart of the town, disappeared, leaving nothing but blackened ruins behind. Each winter a tale of similar desolation comes from almost every town in Japan. Various modes of meeting or preventing calamities of this description have been suggested. A system of national insurance has been proposed; the arrangement of the towns in sections, each surrounded by a large wall, which would confine fires to a single quarter, as in Peking, was mooted last year, but as yet nothing has been done. Expense has generally been the the chief obstacle; but a paper in the last (the 25th) number of the *Mittheilungen der deutschen Gesellschaft für Natur und Völkerkunde Ostasiens*, by Dr. O. Korschelt, a chemist in the employ of the Japanese Government, suggests an economical, and apparently very practicable, way of meeting the difficulty. The paper deals with Japanese soil as a natural cement material. He shows that the usual soils on the plains of Japan, derived from volcanic tufa, closely resemble *puzzolana* and *trass* in composition, and form the basis of an excellent cement. Chemical and mechanical analyses of several of these tufa soils are given; their specific gravity is less than that of any other soils except those containing very large amounts of vegetable matter. Mixed with one-sixth their volume of lime, these soils form excellent cement for building purposes, and the writer points out that by using such materials the Japanese could substitute stone houses for wooden ones in nearly all their provinces in a very simple and economical manner, and thus save to a very large extent the enormous annual waste of substance which occurs through fires. There is no lack of this material; the higher lands of the city of Jedo stand on beds twenty feet in thickness. Referring to the agricultural relations of these soils Dr. Korschelt coincides in the view previously brought forward by Mr. Kinch, that these soils are not by nature chemically rich, at all events in their mineral constituents, but that owing to their physical properties, which in turn are dependent mainly on the large amount of easily decomposable zeolitic silicates they contain, are most admirably adapted to the system of agriculture pursued by the people.

AMONG the papers in the last number of the *Mittheilungen* is one by Dr. Naumann, on the Trias formation in Northern Japan; by Dr. Döderlein on Japanese marine snakes, and the analysis of a fragment of meteorite by Dr. Korschelt.

THE Perthshire Natural History Society have issued Part I of the first volume of their *Proceedings*. It is neatly got up and contains abstracts of the various papers read at the meetings, 1880–81, and an account of the excursions for which the Society is so favourably situated.

THE *Ausland* states that M. Raffray, the French Vice-Consul at Massowah, discovered in the Land of the Gallas in the mountains of Oebul (Sabul?), at ten different places, rocks of which the interior was excavated and transformed into places of worship. He is of opinion that these rocky chapels date from the fifth century.

THE 200th anniversary of the birth of Johann Friedrich Boettiger, the inventor of porcelain, was celebrated at his birthplace, Schleiz (Germany), on February 4. The Royal porcelain factory of Meissen sent an artistically designed votive tablet to the civic authorities of Schleiz, which was fixed to the "Rathhaus" of that town on that day.

THE additions to the Zoological Society's Gardens during the past week include a Mule Deer (*Cervus macrotis* ♀) from North America, presented by Judge Caton; a Bauer's Parrakeet (*Platycercus zonarius*) from Australia, presented by Mr. S. Draper; a Common Buzzard (*Buteo vulgaris*), British, presented by Lord Walsingham, F.Z.S.; a Common Raven (*Corvus corax*) from Scotland, presented by Sir George Leith Buchanan, Bart.; an African Elephant (*Elephas africanus* ♂) from Africa, deposited; two Grey headed Love Birds (*Agapornis cana* ♂ ♀) from

Madagascar, a Common Coot (*Fulica atra*), British, a Blaubok (*Cephalophus pygmæus*) from South Africa, three Pluto Monkeys (*Cercopithecus pluto*) from West Africa, purchased; an Axis Deer (*Cervus axis* ♂), born in the Gardens.

THE INFLUENCE OF MATHEMATICS ON THE PROGRESS OF PHYSICS [1]

IN discussing the value of a given study, a lecturer is by common consent allowed—sometimes even in private duty bound—to exaggerate the importance of his subject, and to present it to his audience enlarged, as it were, through the magnifying power of a projecting lens, so that the details with which he has necessarily to deal may be brought into more prominent view. In an introductory lecture such as it is my duty to give to-day, the speaker need the less feel any scruples in following the usual custom, as different subjects are treated of in successive years, and the hearer may, after the lapse of a short cycle, strike a pretty fair balance between the various branches which have successively been brought before him. But although I might have felt tempted to-day to insist on the advantages of Applied Mathematics as a separate subject not only worthy of study, but second to none in interest and importance, and though I feel no doubt you would have accorded to me the indulgence which everybody requires who endeavours to lay an abnormal stress on the merits of a single branch of human knowledge, I prefer to found the claims of the subject which I have the honour to represent in this college, not so much on its intrinsic value as on the influence it has had on the progress of other sciences. For no subject can stand by itself, and the utility of each must be measured by the part it takes in the play of the acting and reacting forces which weave together all sciences into a common web.

The growing importance of mathematics as an aid to the study of all sciences is daily becoming more apparent, and it may indeed be questioned whether at the present time we can speak of physics as apart from applied mathematics. Riemann's opinion that a *science* of physics only exists since the invention of differential equations is intelligible; but however close the connection between physics and mathematics may be or may become, their growth in the earlier stages has been altogether independent. Galileo may be said to have been the founder of mathematical physics, and amongst his successors have been many who showed a greater inclination towards pure mathematics than towards physics proper. On the other hand, we can trace back the ancestry of our experimental physicist and that of our modern popular books on science to the Middle Ages, where we reach J. Baptista Porta and his books on natural magic. Even eighty years ago the fullest account of the state of experimental science was to be found in "Wiegler's Natürliche Magie," a book of twenty volumes, in which scientific experiments and conjurers' tricks are alternately described. But since the beginning of this century the importance of the mathematical treatment of purely physical subjects has steadily grown, and fifty years ago the two sciences were already sufficiently united to induce the founders of the British Association to join them together into one section. From that time until the present year, when the mass of work necessitated a temporary separation, the experimentalist and the pure mathematician could be seen at the annual meetings listening, or at least appearing to listen, to each other's investigations, and the influence which men of science on these occasions had on each other may be taken to represent roughly the mutual influence of the two sciences themselves; it was substantial, though in great part unconscious. I could not attempt to-day to give you a complete historical survey of the effect which the contact—one might often say the collision—of the two sciences had on the progress of each; even that part of the subject which I have chosen for special consideration is too vast to be successfully confined within the limits of a single lecture, and an incomplete sketch is all I can offer.

The influence of mathematical investigations on physical theories is not restricted to any single stage, but makes itself apparent throughout the whole course of their evolution. Before a theory is even started, the mathematician is often necessary to prepare its way. He has to classify complicated facts in a systematic manner, and working backwards from the phenomena presented by nature, he endeavours to find out which of them are necessary consequences of others, and which of them require independent hypotheses for their explanation. It is in this way that the works of Poisson, Green, Gauss, and of all those who have followed in their footsteps, may be said to have laid the foundation of the theory of magnetism and electricity, although we do not yet as possess any physical notions as to the causes of these phenomena. The true power of mathematics, however, comes into play only when the physical inventor has done his work, and has formed distinct materialistic conceptions which allow themselves to be expressed by mathematical symbols. It is then that the consequences of the theory are to be worked out and tested by experiment. In order to be convinced of the truth of any hypothesis, the scientific world wants quantitative experiments. Numbers form the connecting link between theory and verification, and they always imply mathematical formulæ, however simple these may be. Often two rival theories are on their trial and the mathematician is supposed to find out where their conclusions differ and where crucial experiments are most likely to decide definitely between them. It is remarkable, however, how much more often physical or even metaphysical considerations have decided between two theories than arguments derived from mathematical reasoning. So-called crucial experiments, as a rule, come either too early or too late. Sir Humphry Davy's experiment was absolutely conclusive against the corpuscular theory of heat, but scientific ideas were not ripe yet for the discovery, and his experiment had no marked effect on the progress of science. The crucial experiment here did not involve any mathematical deductions; it is otherwise with that which might have decided between the two theories of light. According to the corpuscular theory, light travels more quickly in water than in air; according to the undulatory theory, the passage through water is the slower, and this distinction is founded on the necessity to account mathematically for the laws of refraction. But when Foucault actually made the experiment, and gave a death-blow to the corpuscular theory, that theory was already dead. There was then only one scientific man of note left who still viewed the undulatory theory with suspicion, and his suspicions were not allayed by the crucial experiment. But if mathematical deductions have not decided as often as they might have done between two rival theories, they have constantly strengthened and confirmed our belief in physical hypotheses by inventing new cases which might test the theory, and which might, if experiment supported the mathematical deduction, establish it on a yet firmer basis.

The most important of all the functions of mathematical physics, however, and perhaps the only one through which mathematics has had an unmitigated beneficial influence on the progress of physics is derived from its power to work out to their last consequences the assumptions and hypotheses of the experimentalist. All our theories are necessarily incomplete, for they must be general in order to avoid insurmountable difficulties. It is for the mathematician to find out how far experimental confirmation can be pushed, and where a new hypothesis is necessary. Facts apparently unconnected are found to have their origin in a common source, and often only a mathematician can trace their connection. It is here that the pure experimentalist most often fails. A new experiment gives results to him unexpected, and he is tempted to invent a new theory to account for a fact which may only be a remote consequence of a long-established truth. Many examples might be given to show how mathematics often finds a connection unsuspected by the pure experimentalist, but one may be sufficient. A ray of light passing through heavy glass placed in a magnetic field, in the direction of the lines of force, is doubly refracted as it comes out. To none but a mathematician is it clear that this is only a direct consequence of Faraday's discovery that the magnet turns the plane of polarisation of the ray on its passage through the glass. Happily this fact was first worked out theoretically; had it been otherwise, we should have heard much of the power of the magnet to produce double refraction.

In addition to the many services actually rendered by mathematical treatment, the mere attempt to put physical theories into a form fit for such a treatment has often been invaluable in clearing the theory of all unnecessary appendages and presenting it in the simple purity which may bring its hidden failings to light, or may suggest valuable generalisations. Instead of dealing, however, in a general manner with the various ways in which mathematics have been useful in the prosecution of physical investigations, it will be better to give a short account of the growth of

[1] A lecture introductory to the Session 1881-82 of Owens College, Manchester, by Arthur Schuster, Ph.D., F.R.S., Professor of Applied Mathematics.

some of our physical theories, and to illustrate the subject of this discourse by a few digressions suggested by the historical development.

As a first example I chose the progress of the undulatory theory of light. There is no other branch of physics in which the power of mathematics has been more successfully shown, nor is there one which shows the relations of experimental to mathematical physics in a truer light. At first we had experimental facts ahead of theoretical explanations; then we had the undulatory theory, which placed theory in advance of experiment; and now again a reversal has taken place, and unexplained experiments will remain unexplained until we shall be able to form more definite ideas of the relations between matter and the luminiferous ether.

Huyghens first worked out scientifically the hypothesis that light consisted of the undulations of an all-pervading medium. But as those who adopted the rival theory professed to explain equally well all phenomena which were then generally known, the scientific world preferred to walk in Newton's footsteps, and to reject what they believed to be the complicated and unnecessary assumption of an universal medium. The corpuscular theory could easily explain the ordinary laws of reflection and refraction. Its attempts to explain the colours of thin plates and the fringes of shadows were less successful, but experimental investigations of these phenomena were not sufficiently advanced to bring these facts prominently into view, nor had their true explanation as yet been given. It was only when mathematical analysis was applied to the undulatory theory that its enormous advantages were discovered. Neither of the men to whom we owe the greatest advance which has yet been made in the science of light was a professed mathematician. Young was a medical man, Fresnel was an engineer; nor was the subject, when these men took it up, in a state which would have attracted a mathematician. Conceptions distinctly physical had to be formed, and assumptions not quite satisfactory had to be made. Their chief claim to our gratitude rests, not so much on the mathematical treatment they have given, as on the fact that they left the subject in a state sufficiently advanced to allow mathematicians, even without special physical proclivities, to take it up, extend it, and establish its foundations more firmly than otherwise they could have done.

The different manners in which Young and Fresnel set to work to prove to the scientific world the truth of their favourite hypothesis, and the corresponding difference in their success is especially interesting for the purpose which we had in view. Both men had considerable mathematical ability, and of the two, Young perhaps had the greater inclination towards pure mathematics, yet he avoided wherever he could the use of mathematical symbols, and disdained to bring forward experimental verification for what he considered sufficiently clear without.[1] It is to Young that we owe most of the physical conceptions which have secured a final success for the undulatory theory of light. He was the first to explain the principle of interference both of sound and of light, and he was the first to bring forward the idea of transverse vibrations of the undulations of light. The most diverse phenomena were explained by him, but their easy explanation was a sufficient proof to him of the theory he was defending, and he did not trouble to verify his conclusions by extensive numerical calculations. It thus happened, that although Young was first in the field in furnishing the true explanation of complicated phenomena, Fresnel, applying mathematical analysis to a much greater extent, had a much more potent influence in turning the scale of public opinion in favour of their common theory.

Though Fresnel's first memoir was published fourteen years after Young had established the principle of interference, Young's writings had remained unnoticed by him as well as by the scientific world in general, and Fresnel was surprised and irritated to hear that another had been in the field before him. But everyone must agree that the chief share in securing the final triumph of the wave theory belongs to Fresnel, nor can there be any doubt that this is due to the mathematical calculations which he applied to cases easily verified by experiment. For there is a great fascination in a table with one column headed "calculated," another headed "observed," and a third giving the differences with the decimal point as much to the left as possible. And it is right that such tables should play an important part in the history of science, for whatever the ultimate fate of a partially accepted theory, the one solid legacy which it will leave behind after its death is the array of numbers for which in its successful stage it has given a sufficiently correct account.

Fresnel invented different pieces of apparatus to test Young's simple supposition, independently made by him, that waves may be made mutually to destroy one another by addition, the crest of one wave being superposed on the hollow of another. It is necessary that the waves should originally be derived from a single source of light, yet they must seem to diverge from two different points. The necessary experimental conditions were fulfilled by the ingenious device of reflecting the light from two mirrors slightly inclined to each other. The light diverging from the two images of one source was allowed to cross, and bands alternately luminous and dark were measured at the places where the waves overlapped. A rough micrometer of his own construction served to measure the intervals between the bands at various distances from the mirror, and Fresnel succeeded in obtaining sufficient data to test his theory. It cannot be my purpose to follow Fresnel and to describe all the various devices which he invented to confirm his views, and to establish the true theory of diffraction. Though he succeeded in making a convert of Arago, the greatest authorities then living, and the most influential men in scientific matters, both Laplace and Poisson disdained to consider the theory. The mathematical basis on which the theory rested seemed to them to be weak and insufficient. No doubt they were right; for many assumptions made by Fresnel were daring, and only justified by the results of further more careful investigations; some of his assumptions even were inaccurate. It was only when the phenomena of polarisation and double refraction were explained that Laplace acknowledged the great power of the undulatory theory, and with a remarkable inconsistency publicly stated his admiration for Fresnel's work, after a paper which is more unsatisfactory from a mathematical point of view than anything else written by Fresnel. The opposition to the undulatory theory offered by the strictly mathematical school no doubt prevented its rapid acceptance by the general body of scientific men, but it is doubtful whether its final success was delayed. On the contrary, Fresnel was spurred on to greater exertions, and the excitement caused by the violent views taken by the opposed parties rendered the question a burning one, which it was necessary to settle definitely. The impartial observers had, at the time of which we are speaking, one strong argument for suspending their judgment. One great class of phenomena, now known under the title of phenomena of polarisation, were unexplained as yet, and it seemed doubtful to them whether the undulatory theory could successfully overcome the difficulty. Then, as before, it was Young who first gave the physical explanation, while it was reserved for Fresnel again to show how the explanation was sufficient to account numerically for all the observed facts.

Those who first started the idea of luminous undulations founded their belief in great part on the analogy between the phenomena of light and those of sound. In a wave of sound each particle moves in the direction in which the waves are propagated, and it was natural to make the same supposition for the waves of light. Yet the mass of unexplained facts forced Young to consider the alternative case of waves in which the motion is in a plane at right angles to the direction of propagation. The waves of water in which such a motion partly takes place may have given to Young the first idea of a supposition which, as he showed, could account for many apparently singular phenomena. But his want of taste for calculations as well as for experimental verification prevented him from reaping the full fruits of his fertile ideas. Fresnel tells us that when he first conceived independently the idea of transverse vibrations he considered the supposition so contrary to received ideas on the nature of vibrations of elastic fluids, that he hesitated to adopt it, and he adds: "Mr. Young, more bold in his conjectures and less confiding in the views of geometers, published it before me, though he perhaps thought it after me." But when once the question was raised, Fresnel applied to it the patient skill which, either by strict mathematical deductions or by happy guesses and assumptions surmounted all difficulties. The phenomena of double refraction and their connection with polarisation were now explained, and all the varied phenomena of light seemed naturally to follow from the simple supposition of waves of transverse vibrations. Such a successful application of mathematical calculations to the investigation of physical phenomena had not been heard of since the time of Newton, and could not fail in the end to produce its due effect. The supporters of

[1] "For my part it is my pride and pleasure, so far as I am able, to supersede the necessity of experiments."—Peacock's "Life of Young," p. 477 Abstract of letter by Young.

Young and Fresnel became more numerous and confident, and the scientific societies duly acknowledged the services rendered by both. Young was elected one of the eight foreign members of the French Academy, and Fresnel received the Rumford Medal of the Royal Society, which, however, only reached him on his deathbed.

The undulatory theory now entered on a stage in which it could be taken up by the mathematician pure and simple. Its foundations had to be rendered more secure, and its consequences had to be worked out to a greater extent than even Fresnel had done.

The scruples which hindered most of the French mathematicians from accepting Fresnel's views were shared by Poisson, who deduced from his equations a result apparently paradoxical. According to Fresnel's formulæ, the centre of the shadow of a small circular disc formed by a luminous point should be as bright as if the disc were absent. But, however curious this result might be, it had been observed just 100 years before Fresnel's time, and as that experiment had been completely forgotten, Poisson's theoretical conclusion had again to be subjected to the test of experiment, when it was found to be completely in accordance with fact.

But the most remarkable discovery made solely by calculation was the so-called conical refraction, theoretically deduced from Fresnel's wave surface by Sir Wm. Hamilton. That great mathematician had found that a point, when looked at through a crystalline plate cut in a certain direction, should appear not as a point, but as a ring, and the fact was verified experimentally by Prof. Lloyd. This discovery has always been considered one of the greatest triumphs of mathematical physics, and justly ranks on equal terms with the discovery of the planet Neptune by Adams and Leverrier. It is necessary to remark, however, that strange and unexpected conclusions, especially when they have been arrived at after complicated mathematical transformations, tempt us sometimes to exaggerate the additional support which their verification gives to the theory by means of which those conclusions have been reached. It is extremely unlikely that any theory should account for all the facts explained by Fresnel, and not also for all those discovered by his successors. As a matter of fact, Fresnel's wave surface is not the only one which has been suggested, but as they all contain the singular points at which the conical refraction is produced, this phenomenon is no proof that Fresnel's equations are strictly correct. It often happens in mathematical explanations of physical phenomena that the equations originally deduced contain a series of constants which are then determined to fit the experiments. This process, which is perfectly legitimate, does however often prove only that the theory is successful in giving us a useful formula of interpolation, and need not be conclusive in favour of the ideas which have led to the formula. In a considerable number of cases, such as the reflection of light from metals, and even the theory of double refraction, we have different formulæ which all give, as far as we can test them, a sufficiently correct account of the facts, and none of them therefore prove anything in favour of the views which the different authors of the equations have put forward.

Before leaving our consideration of the services rendered by mathematics to the undulatory theory, we must not forget to notice the mathematical investigations by means of which its foundations have been placed on a safe dynamical basis. The investigations of Cauchy, those of Green, which followed, but especially those of Stokes, have secured for this theory such a firm support that even Laplace might have accepted it without further scruples. As a matter of history these investigations have done little towards the final victory of the theory. They came too late to affect the course of events, but they have increased the confidence of mathematicians in physical theories, and have prepared the way for further investigations.

As I have already remarked, it is one of the great objects of mathematical physics to investigate how far we can safely push certain assumptions and where a new hypothesis must be brought into play. And, indeed, when we have carried our calculations as far as we can, when we have experimented and measured as much as we can, we find that the undulatory theory as it stands at present, though following up to a certain point with marvellous accuracy the true course of nature, shares the common fate of all theories, and leaves a vast quantity of facts unexplained and waiting for more complete investigations. Nor is this to be wondered at; our assumptions as regards material media may in many cases give correct results and no doubt answer very well as a first approximation, but we arrive at a point where such a material medium can no longer be considered homogeneous, and here our conclusions must break down; but it is to mathematics that we must look for the next great step. The progress of the science of optics during this century has shown us how much mathematical calculation can help to establish a great and important fact such as the existence of that all-pervading medium, the vibrations of which constitute light, and I may review more quickly the recent progress of other branches of science.

In the science of heat we do not require mathematical calculations to show the superiority of the mechanical over the corpuscular theory. Sir Humphy Davy's experiment shows conclusively that heat cannot be a substance, and Joule's experiments served further to illustrate the great advantages of the mechanical theory. The mathematical treatment of thermic problems was not required to establish a theory, but was suggested by practical considerations. The important question, how much work we can get out of a steam-engine first attracted mathematicians, and out of this question the present science of thermodynamics may be said to have arisen.[1] Carnot, who gave the initial impulse to these mathematical investigations, assumed in his papers that heat was indestructible, though he seemed personally inclined to prefer the mechanical theory, which denied that indestructibility. Carnot's investigations were only gradually appreciated, and it was only when Clausius and Thomson corrected his theory so as to bring it into accordance with modern ideas, that general attention was directed to the subject. It was found that so many important consequences of physical interest (as the lowering of the freezing-point of water by pressure) followed out of Carnot's corrected reasoning that the mechanical theory now rapidly made its way, and though, as already mentioned, the proof of its truth rests on a perfectly simple experiment, mathematics must be considered to have had an important share in the final establishment of that theory.

It seems impossible to speak of the services rendered by mathematics to the progress of our knowledge of heat without mentioning the great law of the dissipation of energy. No two sciences seem further apart than mathematics and metaphysics, yet mathematical propositions have often furnished material for metaphysical speculations on the workings of nature. Thus the many dynamical propositions involving minimum or maximum properties, such as the principle of least action, have been taken to show that nature always works with the least expenditure of force, and thus the important law of dissipation of energy, which asserts that the world must have a slow and gradual end, could not fail to be used in the discussion of its sudden and abrupt beginning. These metaphysical speculations react again on the progress of physics, but it seems doubtful how far this indirect influence of mathematics has been beneficial; at any rate mathematicians cannot be held responsible for such an extension of their power.

An offshoot of the mechanical theory of heat is the molecular theory of gases. The idea on which that theory is based is not new, but it remained a speculation merely until, chiefly through the labours of Joule, the mechanical theory of heat was experimentally established, and its laws investigated. There is perhaps no branch of science in which mathematics has had such unexpected results in forming and confirming our faith in purely physical conceptions. That matter is made up of atoms and molecules is an hypothesis which simplifies many physical and chemical problems. It may, on chemical grounds especially, be considered a highly probable hypothesis, but we could hardly have obtained the confirmation amounting to proof which the idea has received of late years, without the mathematical treatment which it has received at the hands of Clerk Maxwell and those who have followed in his footsteps. One of the most astonishing results obtained by Maxwell is the one subsequently verified by experiment, that so long as Boyle's law is true, the coefficient of viscosity, as well as that of the thermal conductivity in a gas, is independent of the pressure. This fact alone, which could never have been obtained without the aid of mathematics, is a sufficiently strong foundation on which we may rest our belief in molecules. It would be extremely interesting to follow out the more recent developments of the mechanical theory of gases, and to show how both mathematics and the absence of mathematics have advanced its progress, but if it i

[1] Foucault's investigations, though of enormous mathematical importan cannot be said to have had a direct influence on the progress of physics.

a good rule to say nothing but good of the dead, it is a better one to say nothing at all of the living.

I have already alluded to the mathematical treatment of electricity and magnetism. The aid of mathematics here was not required to confirm a theory, but rather to prepare the way for one. The complicated laws, regulating the attractions of electric and magnetic bodies, and of bodies carrying electric currents, have by the aid of mathematics been reduced to their simplest form, and electrical units have been connected with the ordinary mechanical units. This interesting branch of physics will furnish us with an example of the services which mathematics has rendered in directing the efforts of experimenters into the proper groove. We need only compare the magnetic measurements which were made during the last century with those made in our own time. While the early investigations gave us only a series of numbers impossible to interpret without a large quantity of accessory data, which are generally omitted, modern measurements, even when made by non-mathematicians, have generally been suggested by mathematical calculations and very often serve a useful purpose.

I have hardly alluded, as yet, to the science of dynamics, which is the foundation of all applications of mathematics. Its progress has been steady since the time of Galileo, but all the marvellous results arrived at by Newton and his followers, results which first showed the great fertility of applied mathematics, are too familiar to need any enumeration from me. The modern researches in hydrodynamics may perhaps not as yet have led to any definite result of physical interest, but they are rapidly progressing towards that end, and we may look forward to an increasing number of physical discoveries made by the aid of mathematics.

In tracing the history of some of our modern theories, I have followed the usual plan of presenting the history of science as illustrated by the discoveries of our great scientific men. It is necessary, however, to draw attention to the fact, and I have tried to keep this point in view throughout this discourse, that it is not always the most conclusive arguments which carry the day, and that secondhand thinkers have often had a more potent influence in shaping the course of scientific history than those to whom we now justly ascribe the greater merit of discovery. In our historical studies, therefore, we ought to direct our attention not less to that which has influenced public opinion, than to the actual soundness and originality of each discoverer.

If we ransack old books of science we often come across passages of long-forgotten writings, in which, when they are properly construed, when new meanings are given to old words and obscure expressions are freely translated, we may trace a faint prophetic glimmering of a modern theory. Such passages have a peculiar charm for the student of scientific history; they are often the only reward for much patient and otherwise useless reading, and are interesting as showing the almost boundless ingenuity both of him who made the statement and of him who interpreted its meaning. But those who are fond of this process of exhumation ought not to forget that two parties are necessary to every advance in science—the one that makes it and the one that believes in it, and the course of history is as much affected by the second class as by the first.

> "A jest's prosperity lies in the ear
> Of him that hears it, never in the tongue
> Of him that makes it."

A scientific man, in so far as he influences the progress of science, cannot be far ahead of his time, and though his writings may be read and admired centuries after his death, he will have written in vain if he has not been appreciated by his contemporaries or by those who immediately followed them. For our present purpose, then, we must consider not so much those mathematical arguments which appear now to us the most conclusive ones, but such as did appear conclusive to those whose opinion they were meant to affect. But if we try to discover what arguments have had the greatest power in removing old prejudices and in causing a solid advance in science, we find that they have often been of the most flimsy nature. Analogies, sometimes not even good ones, have succeeded where solid reasoning has failed, prejudices have been overcome only by other prejudices, and a rough illustration of a point of secondary importance may have made a previously obscure theory look more familiar, though not more clear, to the popular mind. What, for instance, has the existence of Jupiter's four satellites to do with the question whether the earth turns round the sun or the sun round the earth? Yet the discovery of these satellites has produced a greater revolution in favour of the Copernican theory than anything else that Galileo wrote on the subject.

If we look at the history of science from the point of view suggested by these considerations, we find that in addition to the legitimate influence of mathematics which we have traced, its practical effects, through less reasonable causes, have often been as powerful. The statement that in science authority is of no avail against argument, is one the proof of which must be looked for in the future, rather than in the past. There can be little doubt that authority has had a great effect in all scientific revolutions, and the authority of mathematicians was always greater than that of other men of science. Men are thoroughly convinced in one of two ways only; either by a train of reasoning which they can fully appreciate, or by one which is entirely above their comprehension. To those who are particularly amenable to the second kind of proof, mathematics has always been a magic power. Many results first obtained by the help of advanced mathematics have since been deduced by more elementary reasoning, but it seems questionable whether the original author would have been as successful in overcoming the inertia of his contemporaries, if he had confined himself to language intelligible to the greater number of his readers. It is no doubt due to this cause that mathematical papers have brought with them more widespread convincing power than we should now feel inclined to accord to them. The papers of Young, in which he avoided mathematical symbols, may appear to us sufficient to establish the undulatory theory of light; the arguments of Sir Humphry Davy, the experiments of Joule, may seem absolutely conclusive in favour of the mechanical theory of heat; but although the mathematical investigations of Fresnel, Clausius, and Thomson could be appreciated only by a much smaller number of readers, they had a more powerful influence in turning the scale of public opinion in favour of the modern ideas. It seems sometimes almost as if it required an experimentalist to convince a mathematician, and a mathematician to convince the general world. It is impossible to enter into greater detail or to exemplify more amply the assertions which I have made without touching on delicate and controversial matters, but on the present occasion it seemed to me to be specially fitting to point out that the course of science is as much affected by the appreciative faculty of receptive minds as by the creative faculty of the discoverer.

It is given to few only to take an active and successful part in the production of scientific work. The young man who begins life with the idea of making a name as a scientific discoverer is like the little girl in *Punch* who intended to become a professional beauty. They may both be successful, but if so, it will depend as much on the ready appreciation of their contemporaries as on themselves. The advance of science takes place through many channels, and each generation has its own part to play. Particular ideas, particular faculties are wanted at particular times, and no one can foretell where success will be. Men who are now quoted as shining lights would have passed away unnoticed had they lived at other times, and many a life has been one of patient but unsuccessful work, because its energies were devoted to a subject which was barren, or at least lay fallow for a time. No one, for instance, who has attempted to read through J. B. Morinus' work (and I doubt whether any one has ever got beyond the attempt) can fail to notice in him qualities which might have made a successful discoverer. In his method of determining longitudes by lunar distances Morinus has left us a lasting legacy. During the greater part of his life, however, his energies were devoted to the study and application of astrology, and all the labour spent on that subject was thrown away, although he did his best to make his own prophecies come true, and, having predicted the end of the world for a certain year, went through with his share of the proceedings, and died a natural death at the appointed time. *A priori*, there was no reason why astrology when married to mathematics should not have produced a healthy progeny, and looking especially to the state of science at the time, we can have little fault to find with the old astrologers; it is only the long and sad experience of their failure and disappointment that has given us the right to laugh at their unproductive efforts.

History then does not teach us any royal road to success. But more important for the ultimate progress of truth than a solitary success is the training of the faculty which enables the scientific man to judge correctly, and to appreciate the results of those who strike out new roads and extend the boundaries of knowledge. It seems to me to be one of the chief objects of an institution like this to bring up men, who, by conscientious con-

sideration of scientific speculations, may help to give that solidity and elasticity to public opinion which is necessary for the rapid advance of science.

If I say that the study of applied mathematics is pre eminently fitted for the improvement of an acute and correct judgment, I only express a sentiment which, I am sure, is felt by each of my colleagues for his own subject. Where so many attempts are made, let us hope that one may have the desired effect.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Smith's prizes were adjudged as follows:—The first to Mr. Herman, of Trinity College, the Senior Wrangler; the second to Mr. Yeo, of St. John's College, the Second Wrangler.

Mr. W. F. R. Welden, B.A., of St. John's College, has been nominated to study at the Zoological Station at Naples till June 1, 1882.

Among the subjects for which Downing College offers minor scholarships of from 40*l.* to 70*l.* per annum (examination June 6) are Chemistry, Physics, Physiology, Comparative Anatomy, and Botany. No candidate will be examined in more than three subjects, and two of them must be chosen from the first three named. Great weight will be given to special proficiency in one subject. The scholarships are open to non-collegiate students, or to those who have resided less than one term in any college. In June, also, the College offers one foundation Scholarship in Natural Science, open to all members of the University who have not kept more than six terms.

Prof. Stuart has been elected a Member of the Council of the Senate until November 7, 1884, in the place of Prof. Cayley, resigned.

The Burney prize for the present year is to be given for an essay on the following subject: "The Teleological argument for the existence of an intelligent and moral First Cause, as affected by recent Scientific Investigation."

Mr. MacAlister is lecturing at St. John's College on Methods of Physical Diagnosis for medical students beginning chemical work. Dr. Gaskell is lecturing on Respiration; Mr. Lea will lecture in March on Physiological Chemistry.

THE Chair of Agriculture at the Royal Agricultural College, Cirencester, vacant at the close of the present Session, has been offered to and accepted by Mr. Herbert J. Little, of Coldham Hall, Wisbeach.

SCIENTIFIC SERIALS

Journal of the Asiatic Society of Bengal, vol. l. part 2, No. 4 (December 21, 1881), contains: W. T. Blanford, notes on an apparently undescribed species of Varanus from Tenasserim and notes on other reptiles and amphibia.—T. Wood-Mason and L. de Nicéville, second part of rhopalocerous lepidoptera from Port Blair, Andaman Islands, with descriptions and notes on new or little-known species and varieties (plate 14). This last adds twenty-two species to the fauna.—Geoffery Nevill, description of a new species of Rostellaria from the Bay of Bengal (*R. delicatula*).—W. T. Blanford, a numerical estimate of the species of animals, chiefly land and fresh-water, hitherto recorded from British India and its dependencies: Mammals 405, Birds 1681, Reptiles 514, Batrachia about 100, Fishes 1357, Mollusca land and freshwater, about 1000, Coleoptera, 4780, Hymenoptera 850, Lepidoptera 4620, Hemiptera about 650, Neuroptera about 350, Diptera 500 (?) Orthoptera 350 (?) Arachnida 120, Myriapoda 50, Crustacea, land and fresh-water, 100. A glance at these figures and a comparison of them with the number of species known of the Arthropod orders in Europe will show Anglo-Indian naturalists how much there is yet to be done before the fauna of this great country approaches a complete enumeration.—J. Wood-Mason, on *Euripus cinnamomeus*, a new species from North-East India (plate 4).

Annalen der Physik und Chemie, No. 1, 1882.—Determination of temperature-changes in expansion and contraction of metal wires, and the mechanical equivalent of heat, by H. Haga.—Discussions on the Fourier-Poisson theory of heat-conduction, by W. Hergesell.—On the relation of the freezing-point of salt-solutions to their laws of tension, by F. Koláeck.—Remarks on Herr Wullner's note on the spectra of hydrogen and acetylene, by B. Hasselberg.—Fresnel's interference-phenomena treated theoretically and experimentally, by H. Struve.—On the application of the telephone to determining the resistance of galvanic elements and batteries, by E. Less.—On the existence of a dialectric polarisation in electrolytes, by R. Colley.—On the differential pulley, by C. Bohn.—Theory of refraction on a geometrical basis, by A. Kerber.—On the electric resistance of gases, by E. Edlund.—Remarks on Herr F. Auerbach's second paper on magnetic reaction, by G. Wiedemann.—On an apparatus for representing the phenomena of geysers, by the same.—On the Wheatstone bridge, by K. F. Slotte.

Archives des Sciences Physiques et Naturelles, January, 1882.—Experimental researches on the action of poisons on molluscs, by E. Yung.—Memoir on the new registering barometer of the Meteorological Observatory of Lausanne, by H. Dufour and H. Amstein.—The landslip at Elm, by A. Heim.—Researches on the ethers of right tartaric acid, by A. Pictet.

Zeitschrift fur wissenschaftliche Zoologie, vol. xxxvi., part 3 (December 30, 1881), contains:—Dr. G. Haller, on the structure of the Sarcoptidæ (bird parasites—Dermaleichidæ), plates 24 and 25.—W. Mau, on *Scoloplos armiger*, O.F.M., being a contribution to a knowledge of the anatomy and histology of the Annelids, plate 26 and 27.—Elias Metschnikoff, comparative anatomy studies:—(1) Entoderm formation in the Geryonidæ; (2) on some stages of the parasite of *Carmarina*, plate 28.—Dr. August Gruber, on *Dimorpha mutans*, a transition form (Mischform) between the Flagellates and Heliozoa, plate 29.—Dr. August Gruber, a contribution to a knowledge of the Amœba, plate 30.—Prof. Herbst, the natural history of the badger.—Prof. A. Bütschli, contribution to a knowledge of the skeleton of the Radiolarians, especially that of the Cyrtidæ, plate 31-33.

Rivista Scientifico-Industriale, January 15.—On radiophony, by A. Volta.—Two specimens of tourmaline and beryl from Elba (with chromolithographs), and Elban microlite, by A. Corsi.—Insects in winter, by P. Bargagli.—A means of facilitating the preparation of some insects, by P. Stefanelli.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 26.—"The Influence of Stress and Strain on the Action of Physical Forces." By Herbert Tomlinson, B.A. Communicated by Prof. W. Grylls Adams, M.A., F.R.S. Part II. Electrical Conductivity. (Abstract.)

The temporary alteration of electrical conductivity which can be produced by longitudinal traction was measured for all the metal wires used in Part I., both in the hard-drawn and annealed condition, and, in addition, for carbon and nickel.

The electrical resistances of all the substances which were examined, were, with the exception of nickel, increased by temporary longitudinal stress. With nickel, however, of which metal a wire nearly chemically pure was at length with difficulty procured (through the kindness of Messrs. Johnson, Matthey, and Co.), the resistance was found to *diminish* under longitudinal stress not carried beyond a certain point; but after this point had been attained, further stress began to increase the resistance. The effect on nickel appears still more remarkable when we reflect that the change of dimensions produced by the stress, namely, increase of length and diminution of section, would increase the resistance.

The *specific* resistances of all the substances, except nickel and aluminium, were increased by temporary longitudinal stress. With aluminium and nickel the specific resistances were *diminished* by stress not carried beyond a certain limit.

One of the most remarkable features discernible in the results is the similarity of the order of the metals to that of the order of "rotational coefficients" of metals recently given by Prof. Hall (NATURE, vol. xxiv. p. 46; abstract of a note read by Prof E. H. Hall at the meeting of the British Association at York); indeed so striking is the relationship in the case of the metals iron, zinc, aluminium, and nickel, that there would appear to be no doubt that a series of experiments made with a view of determining the effects of mechanical stress and strain on the "rotational coefficients" would be of the greatest value.

Another point to be noticed is that the alteration of the specific resistances of the alloys brass, platinum-silver, and German-silver, is much less than that of the several constituents of these alloys, and at first sight there would appear to be some relation between the alteration of resistance caused by change of temperature and that due to mechanical stress; but it has been proved by these and other experiments that the increase of resistance caused by rise of temperature is in some cases one

hundred times that attending the same amount of expansion by mechanical stress; and, apart from the fact that with nickel and carbon the effects of change of temperature and of longitudinal stress are of an opposite nature, it is evident that the former are to be attributed to other causes than mere expansion.

Compression was proved to produce on the electrical resistance of carbon a contrary effect to that caused by extension; this statement applies to the alteration of specific resistance as well as of the total resistance.

Stress, applied in a direction transverse to that of the current, was also found to produce in several metals both temporary and permanent alterations of resistance of a nature opposite to those resulting from longitudinal traction.

Stress applied equally in all directions by means of an hydraulic press was proved to diminish the resistance of copper and iron; and the experiments showed that the lowering of the temperature of the freezing-point of water can be accurately and readily measured by observations of the change of electrical resistance of a wire.

The total resistance of most metals is permanently increased by permanent longitudinal extension, but with nickel the *total resistance* is permanently *decreased*, provided the extension does not exceed a certain limit: beyond this limit further extension causes the resistance to increase.

The small effects which can be produced by permanent extension, hammering, and torsion on specific electrical resistance were very fully investigated, and are shown in the paper by a series of curves. All the metals examined, except iron and nickel, have their specific resistances increased by strain caused by the above-mentioned processes, provided the strain does not exceed a certain limit, beyond this limit further strain decreases the specific resistance. In the case of iron and nickel, on the contrary, the specific resistance is at first *decreased* and afterwards increased.

The effect on the resistance of annealed steel produced by heating and suddenly cooling was also studied, and it was proved that if the steel be heated to a temperature under "dull red," sudden cooling *decreases* the resistance; whereas if the metal be heated up to or beyond "dull red," sudden cooling *increases* the resistance: the strain, therefore, caused by this process, and that resulting from purely mechanical treatment, are similar as regards their influence on the electrical resistance.

The amount of recovery of electrical conductivity produced by time in wires, which are in a state of strain, is shown in the paper for several metals by a series of curves, and these exhibit most conclusively the superiority of platinum-silver over German-silver when an accurate copy of a standard resistance has to be kept for a long period of time; in fact, of all the metals tested, German-silver showed the most marked recovery of conductivity, and platinum-silver the least.

The recovery of electrical conductivity is in all cases attended with recovery of longitudinal elasticity and of torsional rigidity.

A full examination of the influence of permanent strain on the susceptibility to temporary change of resistance from change of temperature showed that metals may be divided into two classes. In the first of these classes, which includes iron, zinc, and platinum-silver, the strained wire is *most increased in resistance* by rise of temperature up to a certain limit of strain, whilst beyond this limit further strain diminishes the first effect. In the second class, which comprises copper, silver, platinum, and German-silver, the strained wire is *least increased in resistance* by rise of temperature, but that, here again, after a certain point of strain has been reached, the first effect begins to be diminished.

After some trouble, means were found of measuring with considerable accuracy at 100° C. the alteration of electrical resistance due to temporary longitudinal traction, and the experiments led to the belief that the elasticity of iron and steel is not temporarily but *permanently* increased by raising the temperature to 100° C. Subsequently direct observations of the elasticity made in the manner described in Part I., but on shorter lengths of wire, placed in an air-chamber, the temperature of which could be maintained constantly at 100° C., proved beyond a doubt that if M. Wertheim, to whom we owe so much of our knowledge concerning elasticity, had examined the elasticity of iron and steel after these metals, tested at the higher temperature of 100° C., had again cooled down to the lower one, he would have found that what to him *appeared*, in the case of these metals (*Ann. de Chimie et de Phys.*, 3me série, 1844, p. 431) to be a *temporary* increase of elasticity was *really* a *permanent* one, and if the wires used had been tested several times, first at the higher and then at the lower temperature, he would have also found, *provided sufficient rest after cooling had been allowed*, that the elasticity of both iron and steel is *temporarily diminished* by raising the temperature to 100° C.

The temporary alteration of susceptibility to change of resistance from change of stress, which is effected in the case of nickel by raising the temperature to 100° C., is as remarkable as the susceptibility itself, and the maximum diminution of resistance which could be produced by stress when the metal was at the temperature of the room was actually *more than twice* that at 100° C.

The alteration of electrical conductivity which can be produced by magnetisation was carefully studied, and a full account of the modes of experimenting, of the apparatus employed, and the precautions adopted will be fonnd in the paper. The substances examined were iron, steel, nickel, cobalt, bismuth, copper, and zinc, and in all cases, except that of copper, it was proved that longitudinal magnetisation increases the electrical resistance, whether the substance is in an annealed or unannealed condition.

Of all the metals examined, annealed nickel was by far the most affected by a given amount of magnetising force.

The increase of resistance produced by magnetisation can be very accurately represented by the formula $\gamma = a \cdot \alpha + b \cdot \beta$; where γ is the increase of resistance, α the magnetising force, β the induced magnetism, and a, b constants for the same substance when the same amount of current per unit of area flows through the substance.

In the paper, curves are shown exhibiting the connections between increase of resistance, magnetisation, and induced magnetism. From these curves, and from the fact of the above-mentioned formula holding good, it is assumed that the resistance will go on increasing with the magnetising force even when the latter is so great that further increase of force does not produce perceptible increase of magnetism.

The "circular" magnetisation which any magnetic substance undergoes when a current is conducted through it, seems to have very little or no appreciable effect on the electrical resistance of the substance, so that, if we compare the resistances of iron and platinum, the ratio of the two will be independent of the electromotor employed in the "bridge."

The effects of temporary stress on the alteration by magnetism of the resistance of an iron or nickel wire are of a somewhat similar nature to those caused by the stress on the magnetic inductive capacity of these metals, and the same may be said with regard to the effects of the permanent strains due to extension, torsion, &c. Longitudinal stress which may be made to diminish considerably the susceptibility to alteration of resistance from magnetisation, cannot even when carried to the extent of causing breakage, change the *nature* of the alteration.

There is apparently a close relationship between the "viscosity" of a metal and its specific electrical resistance, and it seems very probable that a full investigation of the former of these two physical properties by the method of torsional vibrations would afford valuable information respecting the latter.

Zoological Society, February 7.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. Henry Seebohm, F.Z.S., exhibited and made remarks on a series of Goldfinches (obtained at Krasnoyarsk in Central Asia) which presented every form of transition between *Carduelis major* and *Carduelis caniceps*.—The Secretary exhibited, on behalf of Mr. Peter Inchbald, F.Z.S., two curious hybrid ducks, obtained on some ornamental water near Darlington.—Mr. St. George Mivart read a paper on the classification and distribution of the *Æluroidea*. He regarded this suborder as best divisible into three families—(1) *Felidæ*, (2) *Viverridæ*, (3) *Hyænidæ*. The *Felidæ* he proposed to subdivide into but two genera, *Felis* and *Cynælurus*, the *Viverridæ* into the five subfamilies, (1) *Viverrinæ*, (2) *Galidictinæ*, (3) *Eupleriniæ*, (4) *Cryptoproctinæ*, and (5) *Herpestinæ*. The *Hyænidæ* were referred to two subfamilies—(1) *Protelinæ*, (2) *Hyæninæ*. The author regarded *Cryptoprocta* as a true Viverrine animal, attaching but very little importance to dental characters save as discriminating species and genera. The *Galidictinæ* were arranged to include the genera *Galidictis*, *Galidia*, and *Hemigalidia*, the last-named genus having been instituted for the species previously known as *Galidia olivacea* and *Galidia concolor*. – Mr. W. A. Forbes read a paper on some points in the anatomy of the Indian Darter (*Plotus melanogaster*), and gave a description of the mechanism of the neck in this genus

in connection with the habits of the birds.—A communication was read from Prof. P. Martin Duncan, F.R.S., containing descriptions of some recent corals collected by Mr. J. Y. Johnson at a few fathoms' depth in the sea off Funchal, Madeira.—Mr. Stuart O. Ridley read a paper on the arrangement of the Coralliidæ, and gave a review of the genera and species of this family, which contains the Red Corals. The description of a new species obtained at the Mauritius was given, as well as of an interesting, but probably not new form, said to come from Japan.

Physical Society, February 11.—Annual General Meeting.—Prof. W. Grylls Adams, in the chair.—The president read the report of the council for the past year, from which it appeared that in this, the tenth year of the Society, it was in a highly satisfactory condition, and numbered 331 members.—Sir Charles Wheatstone's papers had been published; Dr. Joule's were soon to be so; and delegates from the Society had taken part in the Electrical Congress at Paris, the Lightning Rod Committee, &c.—The treasurer, Dr. Atkinson, read the audited report of the financial state of the Society; and the following officers were after a ballot declared elected for the ensuing year:—President: Prof. R. B. Clifton, F.R.S.; Vice-president (past president): Sir W. Thomson; Vice-presidents: Prof. G. C. Foster, Prof. F. Fuller, Dr. J. Hopkinson, Lord Rayleigh; Secretaries: Prof. A.W. Reinold, Prof. W. Chandler Roberts; Treasurer: Dr. E. Atkinson; Demonstrator: Prof. F. Guthrie; other members of Council: Prof. W. G. Adams, Prof. W. E. Ayrton, Mr. Shellford Bidwell, Mr. Walter Bailey, Prof. J. A. Fleming, Mr. R. J. Lecky, Dr. Hugo Müller, Prof. Osborne Reynolds, Prof. A. W. Rücker; Honorary Member: Prof. G. Quincke.—Votes of thanks were then passed to the Lords Commissioners of the Committee of Council on Education for the use of the meeting hall, to the past-president, Sir Wm. Thomson, to the Secretaries, the Treasurer and Demonstrator, as well as to the Auditors, Mr. Shellford Bidwell, and Mr. E. Rigg. Prof. Adams then resolved the meeting into an ordinary one, and called Prof. Clifton to the chair.—Dr. C. R. Alder Wright, F.R.S., then read a paper on the relation between the electromotive force of a Daniell element and the chemical affinity involved in its action. The author has investigated the causes which lead to a fall of E.M.F. in a Daniell cell when in action. He found the amount of fall for increasing current densities and plotted it in a curve. The fall was slight when pure commercial or amalgamated zinc, or zinc coated with a film of copper was employed. Amalgamated copper plate gave more rapid rates of fall than electro-coated ones. Dilute sulphuric acid round the zinc also gave a less rapid fall than sulphate of zinc solution round it. In all cases no appreciable fall was noticed when the current did not exceed eight micro-amperes per square centimetre of plate surface. With four to six times the density a decrease of EMF from 0·5 to 1 per cent. resulted, and with currents exceeding 3000 micro-amperes in density per square centimetre of surface, the fall exceeded 10 per cent. A series of experiments were made to determine the fall due to change in the density of the solution by migration of the ions causing a stronger zinc and a weaker copper solution. These showed that with nearly saturated zinc sulphate solution (sp. gr. 1·4) and very dilute copper sulphate solution, the maximum fall in E.M.F. is developed, and is less than ·04 volts; hence the total fall in E.M.F. due to migration of the ions when moderately strong currents pass is only a fraction of the total fall. It follows that the energy due to the actions taking place in the cell, although wholly manifested in electric action expressible in volt-coulombs, when the current is very small, is not wholly so manifested when the current is stronger; the author expresses this idea by calling the energy manifested in electric action *adjuvant*, and the remainder as *non-adjuvant*. He finds that the major part of the latter energy is absorbed in actions having their seat at the surface of the copper plate, and the rest in actions at the surface of the zinc plate. It is transformed into heat according to Joule's law. As a subsidiary result, it appears that the E.M.F. of a Daniell cell, with zinc and copper sulphate solutions of equal specific gravity, a pure amalgamated zinc plate, and either a freshly deposited copper or an amalgamated copper plate, is a standard subject to less departure from the E.M.F. of other Daniell cells than the Clark's standard elements, which appear to vary one from another. On the other hand, a Clark cell keeps sensibly constant to its original value if properly set up) during a period of months or years, at a constant temperature, whereas a Daniell standard falls from its original value after a few hours or days at most.

Entomological Society, February 1.—Mr. H. T. Stainton, F.R.S., president, in the chair.—The President appointed Messrs. Pascoe and Godman and Lord Walsingham as vice-presidents. One new Member was elected.—Mr. E. A. Fitch exhibited a variety of *Strenia clathrata* from Fordingbridge; two larvæ of *Anthroceridæ* from Galway; and a new Myrmecophilous Coleopteron from India.—Mr. C. O. Waterhouse exhibited specimens of *Macromela Balyi*, Crotch, and of two species of *Pentatomidæ* from India.—Sir S. S. Saunders exhibited specimens of *Halticella osmicida*, and read some notes on *Euchalcia vetusta*, Duf.—Papers read: Mr. A. G. Butler, on a small collection of Lepidoptera from the Hawaiian Islands; Prof. Westwood, descriptions of insects infesting *Ficus sycomori* and *F. caricæ*; and Dr. D. Sharp, on the classification of the Adephaga, or carnivorous series of *Coleoptera*.

Geologists' Association, February 4.—Annual Meeting.—The following were elected Officers and General Committee for the ensuing year:—President, W. H. Hudleston, F.G.S., F.C.S.; Vice-Presidents: Prof. T. Rupert Jones, F.R.S., Henry Woodward, F.R.S., Jas. Parker, F.G.S., J. Hopkinson, F.G.S.; Treasurer, J. Logan Lobley, F.G.S.; Secretary, J. Foulerton, M.D., F.G.S.; Editor, Rev. J. F. Blake, F.G.S.; Librarian, Ed. Litchfield; Wm. Carruthers, F.R.S., E. Swain, F.G.S., R. W. Cheadle, F.G.S., J. Bradford, W. J. Spratling, F.G.S., J. Drew, F.G.S., W. Fawcett, B.Sc., F. W. Rudler, F.G.S., H. Hicks, F.G.S., H. M. Klaassen, F.G.S., Prof. John Morris, F.G.S., B. B. Woodward, F.G.S.

Victoria (Philosophical) Institute, February 20.—A paper on evolution as held by Hæckel and his followers was read by Mr. Hassell. The author considered that one of the great defects of Hæckel's theory was, that it required one to believe in great effects resulting from causes which all that we knew of natural history showed must be insufficient.

Institution of Civil Engineers, February 14.—Sir Frederick Bramwell, F.R.S., vice president, in the chair.—the paper read was on air-refrigerating machinery and its applications, by Mr. J. J. Coleman.

EDINBURGH

Royal Society, January 30.—Emeritus Professor Balfour, vice-president, in the chair.—At the request of the Council, the Rev. Dr. Cazenove gave an address on the historical (documentary) evidence for the destruction of Herculaneum and Pompeii by the eruption of Vesuvius, A.D. 79. The references to the catastrophe by contemporaneous authors, such as Martial, Plutarch, Statius, Josephus, the younger Pliny, &c., are so vague and general that they might very reasonably have been discredited if the buried cities had not been actually discovered; and it is first from a work of Dion Casius, published 140 years after the event, that we learn the names of the overwhelmed cities or get any detailed information at all. The inquiry indeed dealt a serious blow to the view held by a certain school, that historical evidence should be based only on contemporary-written records; for in this case it was the non-contemporary writer that gave the precise information.—Prof. Turner described and exhibited certain bones of a Sowerby's whale (*Mesophodon Sowerbyi*) which had been captured in Shetland in May, 1881. From a comparison with the specimen of this very rare species belonging to the Industrial Museum, he concluded that the recently-captured animal was the older, being especially characterised by the presence of a bone running down the centre of the peculiarly elongated snout, and thus filling up what, in the Museum specimen, is a well-marked groove. Probably the ossification had not proceeded far enough in the less mature animal to insure its persistence in the skeleton. The Shetland specimen (a male) also possessed two large teeth on the lower jaw, which, though present in the other, were not large enough to come above the gum. This seemed to indicate a sexual difference.—Prof. Dickson read a paper by Dr. Joseph Bancroft, on respiration in the roots of certain shore plants. His observations referred chiefly to the remarkable rootlets of *Avicennia*. These rootlets grow vertically upwards from the larger roots which extend themselves horizontally in the mud of salt-water creeks. The mud bank around the stem is covered by a brush of such rootlets to a distance of from four to six yards from the bole of the tree. This brush, by entangling *débris*, protects the bank from destruction by stream or tide. The rootlets are studded with pits or pores emitting powdery matter which consists of cells, and which may be observed floating on the surface of the brackish water of the creek. These pores he regards as corresponding to

lenticels, and he finds that when air is forced into the cut end of a rootlet it issues by the pores. Hence he conjectures that the function of the pores is to contribute to the aëration of the plant, a view coinciding with that held by several botanists as to the lenticels, which they regard as structures affording, like stomata, a communication between the atmosphere and the interior of the plant.—Prof. B. Balfour presented three Latin diagnoses prepared by Dr. J. Müller, Dr. G. Dickie, and Dr. C. M. Cooke, of the lichens, algæ, and fungi collected by him and partly by Dr. Schweinfurth in the Island of Socotra.—Prof. Tait communicated a note by Prof. Piazzi Smyth, who, with the aid of a very superior spectroscope, has recently discovered that the low-temperature spectrum of oxygen does not consist of five *unique* lines as hitherto believed, but that four at least of these are triple or quadruple, and have the fluted appearance common to other low-temperature gaseous spectra.

Paris

Academy of Sciences, February 13.—M. Jamin in the chair.—The deaths of M. Bussey, free Academician, and M. Decaisne, member in Rural Economy, were commented upon. Discourses at the funeral of the latter, by MM. Bouley, Fremy, van Tieghem, and Deschartre.—On the law of deviation of Foucault's pendulum, by M. Bertrand.—On some applications of the theory of elliptic functions, by M. Hermite.—On a new memoir of M. Hirn, "Experimental researches on the relation between the resistance of air and its temperature, by M. Faye. This memoir (noticed in NATURE, vol. xxv. p. 325) M. Faye regards as an important and pregnant scientific event.—On double salts formed by haloid salts of mercury, by M. Berthelot.—Effects of hypnotism on some animals, by M. H. Milne-Edwards. Fowls, &c., hypnotised several times by M. Harting were injured in the nervous system; they were paralysed and died. M. Milne-Edwards thinks the increased aptness of persons often hypnotised, as subjects for demonstration, is a bad sign, and that hysteric persons should not be often so treated.—Proofs of the breaking up of a southern continent during the modern age of the earth, by M. Blanchard. New Zealand and small adjacent islands (Auckland, Maquarie, Chatham, Antipodes, Bounty, and probably others) he regards as the *débris* of this old continent; finding evidence chiefly in the similarity of living things, and also in soundings and in the disappearance of the huge Moas (which he thinks explained by changes in the land, the birds having then been huddled together in small space, and perishing by hundreds). M. Alph. Milne-Edwards passed some strictures on M. Blanchard's conclusions, holding, *inter alia*, that the Antarctic islands (such as Auckland and Campbell Islands) were not formerly connected to New Zealand. M. Blanchard replied.—On the roots of sanitary matrices, by Prof. Sylvester.—Researches on the nitrogen-acids derived from acetones, by M. Chancel.—On the various nervous states produced by hypnotisation in hysteric persons, by M. Charcot. He distinguishes the cataleptic, the lethargic, and the somnambulic state.—On a spouting thermal water obtained in the plain of Forez, by M. Laur. Boring to a depth of 502 m. they observed at irregular intervals eruptions of carbonic gas projecting a column of hot water 26 m. for 20 minutes. The vertical tube had a diameter of about 8 inches. Changes of water level accompany the phenomenon.—On the employment of bitumen of Judæa against diseases of the vine, by M. Alric. He quotes information from an account of the journey of Nassiri-Khosan in Syria and Palestine. It is said that phylloxera in Palestine, in the Middle Ages, was suppressed by means of this bitumen. M. Dumas promised an analysis of the substance, a small barrel of which had been sent to the Academy.—Observations of planets 221 Palisa and 222 Palisa at Paris Observatory, by M. Bigourdan.—On the companion of the star γ of Andromeda, and on a new mode of regulation of an equatorial, by M. André. A 6-inch equatorial lately set up by MM. Brunner in Lyons Observatory decomposes clearly (with a magnification of 200) the star named, an effect generally regarded as a test for 8-inch objectives, and which seems only to have been once bad before, with aid of a With silvered mirror. In regulation MM. Brumer use a spirit level and a nadir ocular.—On the distribution, in the plane of roots, of an algebraic equation whose first member satisfies a linear differential equation of the second order, by M. Laguerre.—On singular points of differential equations, by M. Poincaré.—On the forms of integrals of certain linear differential equations, by M. Picard.—On a case of reduction of Θ functions of two variables to θ functions of one variable, by M. Appell.—On quadratic forms with two series of variables, by M. Le Paige.—On the divisibility of certain quotients by powers of a certain factorial, by M. André.—On shock of elastic bodies, by M. Pilleux. He describes some instructive experiments with ivory cubes hung in a row, and an ivory ball allowed to impinge on them.—Electric actions in similar conducting systems, by M. Deprez.—On the electric transport of force to great distances, by M. Deprez. With small modified Gramme machines weighing about 100 kg. he has got a useful work of 37 kgm. with an interposed resistance of 786 ohms, representing 78·6 km. of ordinary telegraph wire.—On methods of comparison of induction coefficients, by M. Brillouin.—On the generality of the electrochemical method for figuration of equipotential lines, by M. Guébhard.—Hydrodynamic experiments; imitation, with liquid currents, of the phenomena of electromagnetism, by M. Decharme. He uses, instead of the pulsating or vibrating bodies of Bjerknes (in water), liquid currents, continuous or interrupted, acting in air or water. He describes a hydro-electromagnet with interrupted currents.—Polarimeter with ordinary light, by M. Laurent. He introduces into an ordinary polarimeter, between the tube and the analyser, a Soleil compensator, with prismatic quartz plates.—On oxychlorides of magnesium, by M. André.—On oxychlorides of sulphur, by M. Ogier.—Action of cyanide of potassium on trichloracetate of potassium, by M. Bourgoin.—On the heat of formation of ferricyanhydric acid, by M. Joannis. He arrives at the number +28o·5 cal.—On galactine, by M. Muntz. This is a gum which he extracts from grain of lucerne; it is marked by high dextrogyrous rotatory power, and the property of giving, with dilute acids, the products of decomposition of milk-sugar. Leguminous grains, especially, contain large quantities of it.—On aconitrates, by M. Guinochet.—On hieratite, a new mineralogical species, by M. Cossa. This is named from *Hiera*, the Greek for Vulcano Island (Lipari), where the substance is found near the fumaroles of the crater. The composition agrees with that of fluosilicate of potassium, a salt not previously found among natural products.—Atlantic actinia from dredges of *Le Travailleur*, by M. Marion.—On fossil Echinida of the island of Cuba, by M. Cotteau.—On asterophyllites, by M. Renault.—On the nature of spheroliths forming an integral part of eruptive rocks, by M. Lévy.—On the discovery of marine carboniferous formation in Upper Alsace, by M. Bleicher.—On the anomalies of the atmospheric pressure in January and February, 1882, by M. Renou. The sky was overcast continuously for fifteen days (January 11 to 26); the bright days were warm, the dull days cold (contrary to what usually occurs in winter). From January 9 to February 7 no rain fell. The Marne and Seine were very low and extraordinary clear.

Vienna

Imperial Institute of Geology, January 24.—Dr. Tirus, on the Scoglio of Brusnick in Dalmatia.—A. Rzehak, on oncophora, a new genus of Bivalvæ.—Th. Fuchs, on the pelagic fauna and flora.—C. M. Paul, on the region of Sanok; and Lupkow, in Gallicia.—M. Vacek, on the geology of the Nousberg.

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THURSDAY, MARCH 2, 1882

AMERICAN ANTS

The Honey Ants of the Garden of the Gods, and the Occident Ants of the American Plains. By Henry C. McCook, D.D. (Philadelphia: Lippincott and Co., 1882.)

LOOKING to the extensive and systematic work which Dr. McCook has already accomplished in the study of some of the most interesting species of New World ants, we are exceedingly glad to observe from this additional volume that he has now turned his serious attention to the honey ants, for, although the habits of this species were known to be certainly among the most remarkable of the many remarkable habits that are presented by the Hymenoptera, they have not hitherto engaged the study of any competent observer. As he himself observes, "Very little of their habits has heretofore been known, and only the forms of the honey-bearer and worker-major. In order, if possible, to remove this reproach from entomology, I started in the early part of July, A.D. 1879, for New Mexico."

In giving a short abstract of the results which have rewarded his energy, we may best begin by describing the forms or "castes" which Dr. McCook found to constitute a colony of honey ants. There are (1) three castes of workers, namely, major, minor, and minim or dwarf—the first being $8\frac{1}{2}$ mm. in length, the second 7 mm., and the third $5\frac{1}{2}$ mm. (2) Honey-bearers, "a sedentary class or caste distinguished by abdomens distended into a spherical form of expansion of the crop filled with grape sugar: the length (including abdomen) is 13 mm. (one-half inch); the proportions and description of the head and body are those of the worker-major, of which it may be a developed form." (3) Female, or queen—length 13 mm. (4) Male—length 5 mm.

Regarding the economy of the hive, the first important point established by Dr. McCook's observations is that the honey-bearers do not, as has been asserted, themselves elaborate the honey, but that this is gathered by the workers from a peculiar kind of vegetable gall, and by them poured into the crop or proventriculus of the honey-bearers; the honey-bearers are therefore nothing more than living store-houses for the food of the hive, their relation to the rest of the community being, as Dr. McCook observes, similar to that of the honey-comb cells to the hive bee. For not only do the worker-ants store the "rotunds," but when they require food they go to the rotunds, which feed them by pressing out a drop of their store from the œsophagus. Likewise "the queen, virgin females, males, and the teeming nursery of white grubs" are all dependent on the rotunds for nourishment. The honey is collected from the galls by the workers at night, the insects being very intolerant of sunlight, and quickly dying when exposed to it. The honey pressed from the body of the rotunds has a pleasant taste, somewhat resembling ordinary honey, but more aromatic, slightly acid, and contains a larger proportion of water—being, therefore, more limpid. It requires about 1000 honey-bearers to yield one pound weight (troy) of honey. Dr. Wetherill says, as the result of analysis, that the substance is "a nearly pure solution of grape-sugar which is in a state of hydration isomeric with grape-sugar, and differing from grape-sugar in not crystallising."

The working ants are so fond of the honey stored within the rotunds, that when, in making sections of the nests, Dr. McCook ruptured the abdomens of the rotunds, he always observed that, "notwithstanding the high state of excitement which pervaded the colony, the ordinary instinct to defend the nest and preserve the larvæ, cocoons, and other dependents, was at once suspended in the presence of the delicious temptation." It is therefore the more remarkable that when a rotund dies the workers do not open the abdomen to get at the contained honey, but, after severing the abdomen from the thorax, remove each part separately to a "cemetery," or common burying-ground which these ants, like many other species, maintain. The author suggests, and not improbably, that this forbearance on the part of the workers may be explained as "the result of an instinctive sentiment by which Nature guarantees protection to the living honey-bearer."

The partly-filled rotunds are not wholly dependent for their food upon the gorging process to which they are submitted by the workers, for when only partly filled, they will feed themselves on sugar; but the author never saw "a honey-bearer of full rotundity taking food or drink." But the fact that before this insect is largely distended with honey it will feed itself points to the supposition that it may be itself a worker, slightly, if at all modified in structure; and this supposition is borne out by anatomical investigation. For the latter has shown: (1) "that it is the *crop alone* which contains the nectar received at the mouth"; (2) "that the organs of the abdominal portion of the alimentary canal are ordinarily in a natural state, except in so far as their position has been changed by the downward and backward pressure of the expanding crop"; and (3) "that the process by which the rotundity of the honey-bearers has probably been produced has its exact counterpart in the ordinary distension of the crop in over-fed ants; that at least the condition of the alimentary canal in all the castes is the same, differing only in degree, and therefore the probability is very great that *the honey-bearer is simply a worker with an overgrown abdomen.*" "Why the extraordinarily distended crop seen in the honey-ant should be limited to two species (so far as known), and why so limited a number of workers in the formicaries of these two species should develop the round abdomen, are questions that provide sufficient wonder, but yield scant satisfaction."

The degree of distension which the crop of a fully-gorged rotund undergoes is certainly most surprising. Among the thirteen plates with which Dr. McCook's work is illustrated, several figures are given of the crop in various stages of repletion. In the comparative scale of representation adopted, the empty crop is drawn about the size of a pea, and the fully distended one about that of a tennis ball.

Regarding less special points of interest, we may notice the "absence of individual beneficence." Not a single instance of such beneficence was noticed, although closely watched for, while the exhibitions of an apparently cruel neglect were many. Thus, "the grains of sand and soil were heaped around the rotunds, until the poor creatures

were literally buried alive. It would have been easy for the busy masons to draw their fellows aside and thus carry on their work. But it either never occurred to them to do so, or the disposition was wanting." This, however, applies to the case when the ants are engaged in making a new nest after having been transferred *en masse* by the author to hitherto unbroken ground. But "in the natural sites the workers showed great interest in the preservation of the rotunds, dealing with them very much as with the larvæ." In these natural sites the rotunds hang suspended by their claws, backs downwards, from the roof of their underground chamber, and if they fall to the floor they are unable to move from the spot on account of their unwieldy mass. In such a case several workers "would join in removing one rotund pushing and pulling her along. . . . Another sketch represents a worker-major dragging a rotund honey-bearer up the perpendicular face of a cutting made in the excavation of the nest. The mandibles of the two insects were interlocked, and the worker *backed* up the steep, successfully drawing her *protégé*." It seems, however, to have been undetermined whether in such a case the worker restores the rotund to her place on the roof of the chamber; it is certain that they did not do so in the author's artificial formicaries, for although the fallen rotunds "were faithfully attended, often cleansed and caressed, in no single instance did the workers attempt to right them and restore them to the roof."

It will be seen from this brief epitome of Dr. McCook's results that, while adding a number of new facts, they partly confirm, and partly contradict the previously published statements of Llane (1832) and Wesmael (1838). But, as Dr. McCook himself observes, "One of the most perplexing accounts of the honey ant is that of Mr. Henry Edwards," who recorded the statements from a verbal description given to him by Capt. W. B. Fleeson, whose observations were made at or near Santa Fè. This description was first published in the *Proceedings* of the California Academy of Sciences (vol. v. p. 72, 1873), and afterwards in the columns of this journal. Its chief points were that the honey-bearing ants are suspended to the roof of this chamber by meshes of web, that there are three very distinct castes, if not species and genera of ants forming a colony, that the larger kind form a fortress of a most remarkable character, and also gather leaves and flowers which they deposit in the middle of their fortress, leaving them to be then conveyed by ants of a second species to the honey-bearers as food. The remarkable fortress was described as being formed in the shape of a perfect square, having one side open and always facing due south, while round the remaining three sides the ants of the larger species were described as perpetually parading in a double line of defence. None of these assertions have been corroborated by Dr. McCook, and therefore he may be excused for suggesting that Capt. Fleeson may perhaps have been "testing the credulity of the writer by one of those jokes of which naturalists are occasionally the victims." "But," he adds, "if the narrative is to be taken in good faith, I can only explain the facts by supposing that the observer happened upon a nest of cutting ants (*Atta fervens*) within whose boundaries a nest of Melliger had chanced to be established, and had confounded the habits of the two as those of one formicary; or, second, that the cutting ants, or some other species of a similar economy, has really acquired the habit of kidnapping and domesticating the honey-ant for the sake of its treasured sweets, precisely as many ants domesticate aphides." "The porterage of leaves, &c., into nests is not an uncommon habit among ants of divers species; therefore, without stopping to discuss the question whether such material may contribute to the food supply of the formicary, it may be remarked that its most probable and ordinary use is for purposes of architecture or nest-building."

After again reading the account as published by Mr. Edwards, we cannot entertain the suggestion that he has been the victim of an intentional hoax. But as the suggestion has been made by an honest and independent observer, we feel it to be incumbent on those who were responsible for the publication of the account to repudiate the insinuation of dishonesty; and, looking to the definite nature of the statements which that account contained, we feel it is now more desirable than ever that they should be either verified or disproved by some competent naturalist visiting the locality where the observations are said to have been made.

The second part of Dr. McCook's volume treats of the Occident Ants of the American Plains. These build mounds from less than half a foot to more than a foot in height, round which they make a circular "clearing" of grass and other vegetation, presumably by cutting it away after the manner of the agricultural ants of Texas, previously described by the same author. The mound is always covered with pebbles which have been removed in the process of excavating the underground chambers and galleries. Some of the pebbles so transported are ten times the weight of the ant, so that the labour performed would be paralleled by that of a man if he could carry half a ton up a staircase one-third of a mile high.

These ants do not begin their labour till eight or nine o'clock in the morning; so, as Dr. McCook seems not unwilling to observe, "it might not be unmeet that those persons whose love of sleep during late morning hours has been disturbed by the familiar Scripture proverb, 'Go to the ant, thou sluggard; consider her ways, and be wise!' should return upon their mentors with the above-recorded facts, and cite this ant, who is indeed no sluggard, as being nevertheless fond of a morning nap." The day's work, or at any rate the day of out-door work, begins by opening the gates which had been closed the previous evening. "The manner of opening the gate cannot be fully described, because the work is chiefly done within and behind the outer door of gravel. The mode would doubtless be correctly indicated by reversing the process of closing gates, presently described. What I saw was, first, the appearance of the quivering pair of antennæ above one of the pebbles, followed quickly by the brown head and feet projected through the interstices or joints of the contingent gravel-stones. Then forth issues a single worker, who peeps to this side and that, and after compassing a little circuit round about the gate, or perhaps without further ceremony, seizes a pebble, bears it off, deposits it a few inches from the gate, and returns to repeat the task; she is followed, sometimes cautiously and at intervals of ten, twenty, even thirty minutes, by a few other ants, who aid in clearing away

the barricade, after which the general exit occurs. Again there is a rush of workers almost immediately after the first break, who usually spread over the hill, bustling around the gate, gradually widening the circles, and finally push out into the surrounding herbage. At first the exit hole is the size of a pea, perfectly round, and plainly shows that sand and soil have been used under the gravel to seal up the gate. The whole appeared to have been cemented, probably by the moisture of the night dew.

"The process of closing the gates is even more interesting to the observer than the opening, as the various steps are more under his notice. . . . At nest A the closing was chiefly from within. The workers pushed the sand from the inside outwards with their heads. A grass straw about an inch long was brought from the interior and pushed out until it lay across the gate as a stay for the filling material. Soil was here principally used for closing, a few pebbles being added." In another case, "when the gate was nearly closed a straggling minor came back from the commons and essayed entrance, wherein she failed. Several trials and failures succeeded, whereupon she commenced dragging the dirt from the opening. While thus engaged the major approached with a huge bit of gravel, which she deposited on her comrade with as much nonchalance as though she were one of the adjoining pebbles. At last the minor dug out a tiny hole through which she squeezed into the nest, and the major, who was deliberately approaching close behind her, carrying another pebble, immediately sealed up the opening. During this amusing episode the straggler made no effort to aid in the closing, being wholly intent on entering, and the gate-closer paid no attention to her whatever, beyond the first sudden and satisfactory antennal challenge. Each moved forward to her own duty with the undisturbed plasticity of a machine."

This "by-play" between the gate-closers and the late-returning foragers is not the exception but the rule; nevertheless it does not appear that the foragers ever so far miscalculate their time as to arrive after the gates are completely closed. When the gates are all but closed there is generally but a single ant engaged in the closing process from without; this ant slips in at the last moment, and the process is finally concluded from within. The gates are similarly shut during the day-time if the weather seems to threaten a heavy rain-storm.

In disposition the Occident Ants, though provided with very formidable stings, are exceedingly mild and unwarlike—so much so, indeed, that even when greatly incommoded by the tiny but viscous erratic ants which Dr. McCook observed on one occasion to have impertinently established a nest within their "clearing," they would not dislodge or even fight their insignificant foes, but "entirely abandoned their old avenue, cut down and around the erratic colony, and made an opening on the edge of a slight ridge several inches beyond the disputed territory, but still in the line of the avenue which they had been using in their work. A tithe of the pains required for this task would have literally cut out and carried away the whole nest space of the erratics, whose scant numbers of diminutive warriors could have been overwhelmed in a moment by the legions of their huge hosts."

Lastly, Dr. McCook has satisfactorily ascertained that these Occident Ants present the same habits of "harvesting" as those which were previously known to occur in the allied species of Florida and Texas. His work as a whole deserves warm commendation, and we trust that the success which has attended his study of the sundry species of ants that have hitherto engaged his attention, will induce him to extend his researches to those other species on the American continent which present habits and instincts, if possible, more remarkable than those which he has done so much to elucidate.

GEORGE J. ROMANES

OUR BOOK SHELF

The Story of our Museum, showing how we Formed it, and what it Taught us. By the Rev. Henry Housman, A.K.C., &c., &c. (London: Society for Promoting Christian Knowledge, 1881.)

THIS is a most excellent book for a boy with a taste for natural history. It describes in a pleasing and natural way how two boys living in a country village in Gloucestershire began to make a museum. It narrates all their difficulties, their failures, and their successes; and how, by perseverance, and with very little expense, they gradually formed a collection illustrating the whole range of the natural history and antiquities of their district, including, besides, postage-stamps and autographs. How much pleasure and how much knowledge are to be obtained while forming such a collection is very well shown; and though there is little novelty in the book, occasional diffuseness in the treatment, and hardly any passages that will bear separate quotation, these trifling deficiencies do not at all detract from its merit as a book for boys, which is all that it pretends to be.

The one decided innovation on the almost universal practice of collectors is, the strong recommendation of a natural system of mounting butterflies and moths. The usual mode of exhibiting the lepidoptera, all set out with expanded wings on one horizontal plane, is objected to as being monotonous and completely false to nature. Of course in an extensive systematic collection this method is absolutely necessary, for classification, easy reference, comparison, and critical examination; but in forming a purely local collection, the superior advantage of the natural system of mounting are strongly advocated, at least for the butterflies and all the larger moths. These should be exhibited sitting or flying, with the wings elevated or depressed, as if alive, and the legs and antennæ placed in natural positions. Of course this requires glass cases for these insects as for birds; but when the collection is restricted this is no objection; and by exhibiting the preserved larvæ, eggs, and pupæ, along with the perfect insects in all their different natural attitudes, it is maintained that much more instruction will be afforded, while the effect will be far more picturesque and pleasing than the straight rows of unnaturally expanded insects can ever be.

The only other part of this volume calling for further notice here, is an appendix, "On the Arrangement of Natural History Collections," in which the more natural and attractive arrangement of the galleries of public museums is strongly advocated. As regards the higher animals, there is nothing fresh in these recommendations; but the author also urges the exhibition of complete series of such fossil species as illustrate the persistence of types or the development of forms throughout considerable geological periods. This, however, is never done in our great public museums. In the case of living animals the species are exhibited in systematic groups, while no attempt is made to show the equally interesting geographical grouping; while with extinct animals an opposite

mode is followed, and all are arranged stratigraphically, without any attempt to show the more interesting developmental or time-series. Thus, in both cases the most interesting and instructive methods of arrangement are entirely neglected in favour of systems which are adapted solely to facilitate study by specialists, but which are comparatively unimportant and uninteresting to the public. Even to this day it does not seem to be realised by curators of museums, that the collections for study and those for public exhibition require to be arranged upon totally distinct plans; and that the method which is the very best in the one case may be, and usually is the very worst in the other.

ALFRED R. WALLACE

Geology of the Counties of England and of North and South Wales. By W. Jerome Harrison, F.G.S. (London: Kelly and Co., 1882.)

ALL who have had occasion to use the valuable Post Office Directories of the English counties published by Messrs. Kelly and Co., will have noticed that the imperfect notes on geology contained in former editions have now been replaced by very accurate and well-written articles on the subject. These notes on the geology of the English counties have been drawn up, evidently with much skill and labour, by Mr. W. J. Harrison. In each case the scattered maps and publications of the Geological Survey have been very carefully studied, and the various memoirs and notices on the geology of each of the counties contained in miscellaneous journals and magazines faithfully summarised. The result is that the numerous readers of those widely diffused publications, the County Directories, have at hand a reliable sketch of the geology of the district in which they live, carefully brought down to the date of publication. What is perhaps of still greater importance is, that these sketches include references to all the principal works bearing on the subject, so that the reader is told where he may find fuller and more detailed information upon any point in which he may be interested. We can scarcely conceive a method by which useful geological information could be more widely diffused, or made more easily available for those who wish to obtain correct ideas concerning the geology of the district in which they live. These sketches of the Geology of the English Counties have now been collected into a volume, and constitute a very useful work of reference. We have tested it in many ways, and find that in almost every case the latest information, even when published in journals of very restricted circulation, has been discovered and made use of. Mr. Harrison's essays are clearly written, and each of them is preceded by a list of the local Natural-History and Scientific Societies, the members of which collect information bearing on the geology of the county; of the museums in which rocks and fossils from the county are preserved; of the publications of the Geological Survey bearing on the county; and of such other works as in any way refer to the subject. In all cases where he was in doubt Mr. Harrison appears to have sought the assistance of competent authorities, the result being a work which is exact, and at the same time is written in a popular style. There are numerous excellent woodcuts, most of which appear to be taken by permission from the publications of the Geological Survey and the Geological Society. We can heartily recommend this book as a convenient and reliable work of reference.

University College Course of Practical Exercises in Physiology. By J. Burdon Sanderson, M.D., LL.D., F.R.S., with the Co-operation of F. J. M. Page, B.Sc., F.C.S., W. N[illegible], F.C.S., and Aug. Waller, M.D. 8vo, pp. 75. (London: H. K. Lewis, 1882.)

THIS book is a *multum in parvo*. It gives in a most condensed and yet most clear and precise form, an account of the method of performing the most important experiments in physiology. It will be useful not only to students, but to practitioners who wish, with a small expenditure of time and labour, to become acquainted with the present state of our information, and the most important points in physiology, and the experimental data on which our knowledge rests. The exercises relating to the physiology of muscle and nerve are especially worthy of commendation. They make clear to the student the different arrangements of electrical apparatus, the comprehension of which is to many an insuperable difficulty, not only during their student's career, but during the whole of their lives. The few and simple diagrams in the text are just what were wanted to make the experiments readily understood. Half an hour spent with this little work will, we think, give to the beginner a better grasp of the subject of which it treats than days spent over more elaborate text-books, however good the latter may be for advanced students.

Mémoires de la Société des Sciences Physiques et Naturelles de Bordeaux 2[e] série, tome iv. 2[e] cahier. (Bordeaux: 1881.)

WE draw attention to this number specially for the benefit of such as are interested in the early history of arithmetic. It contains (pp. 161-194) an able paper by M. Paul Tannery (who is known by his previous similar work upon the "Collection Mathématique" of Pappus in tome iii. pp. 351, &c., of these same *Mémoires*) on "l'Arithmétique des Grecs dans Héron d'Alexandrie." He goes carefully into the question of the authenticity of the several so-called Heronian writings, and analyses those which he accepts, and concludes with one or two specimens of the approximate methods employed. We need only mention the names of Cantor, Martin, Hultsch, and Rodet as being those of the authors whose works and statements are discussed. Other papers are: M. Hautreux, "Etudes météorologiques de la Gironde à la Plata"; M. Millardet, "Pourridié et Phylloxera; étude comparative de ces deux maladies de la vigne"; M. Royer, "Récherches sur le passage du mercure à travers les liquides"; and M. Ponsot, "De la reconstitution et du greffage des vignes." From this enumeration it will be seen that some of the papers are of a very practical character, touching the interests of the commonalty. M. Debrun contributes a short note (and illustration), "Sur un nouveau baromètre amplificateur."

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Hypothetical High Tides

I SHOULD like to be allowed to ask two questions on this subject: First. Could the vegetable accumulations from which the coal has resulted have escaped destruction if, during their subsidence, the world was subject to such tides as Mr. Ball postulates? It is difficult to understand how this could be if the shales and sandstones which overlie the coal are of marine or estuarine origin. Second. What do the Palæozoic conglomerates disclose on the subject? The shingle of [illegible] heaped up by the tide, having each layer of sand and pebble laid at the slope of the beach face, exhibits when cut at right angles to the trend of the beach the continuously oblique bedding which represents this slope, the vertical heights of the shingle bed thus laid up representing the extreme rise and fall of the tide and surges. This may be seen in the case of the Lower Eocene shingle in Bickley Cutting of the Dover Railway and in the case of the early Glacial shingle in deep pits at Henham and Halesworth in Suffolk. The latter show a tidal rise and fall there of more than twenty-five feet, the former not so much. The same structure obtains in the case of sandbanks left dry by the tide, and of such

nearly all the Red Crag consists, the oblique layers of sand and shell corresponding to the oblique layers of sand and shingle in beaches. I have seen this structure extending for some distance in a railway cutting through Jurassic sandstone, but there was nothing to indicate that the tidal slope under which it was formed was greater than in the case of the Crag. It may be otherwise for aught I know with the old conglomerates, for I am not acquainted with them. S. V. WOOD

DR. CALLAWAY points out that there would be nothing in the nature of the older deposits to indicate the existence of excessive tidal action. One point, however, suggests itself to me in connection with the increased force of winds and currents, which must necessarily have accompanied the high tides and more rapid rotation of earlier epochs.

While the general nature of the Palæozoic strata indicates that they were deposited along the margins of continental or insular masses of land, there is a remarkable absence of estuarine conditions in the older Palæozoic rocks. Indeed, except in some portions of the Carboniferous deposits, in which beds of coal occur together with such marine species as Goniatites and Aviculopecten, there seem to be no beds of Palæozoic age which can with certainty be referred to an estuarine origin. The earliest plant-remains, such as *Eophyton*, from the Fucoidal sandstone of Sweden, are probably marine algæ, which currents might transport to great distances from land.

Now considering the frequency with which delta deposits occur in Neozoic strata, the almost entire absence of them during the immense earlier periods is a fact which seems to require some explanation.

Now it seems highly probable that excessive tides would have disturbed even inland seas (if any existed at that time) which are most favourable for the accumulation of deltas, and that strong marine currents would scour out even those sheltered estuaries, which, with moderate tides, would have been, like those now existing in the Mediterranean, comparatively free from tidal action. The delta of the Ganges is nearly the only instance of a great river delta forming in spite of tidal fluctuations; but, although the average height of the tide here seldom exceeds 10 feet, even this moderate amount is sufficient to prevent the delta from pushing its way far out to sea.

Another point which must not be lost sight of, in considering the influence of stronger oceanic currents, is the greater distance to which the coarser materials might be carried out to sea; so that it would not necessarily follow that those deposits, which we are accustomed to regard as evidence of the proximity of land, are of littoral origin. For with strong currents, even coarse grits and conglomerates might be widely distributed over the ocean floor. J. VINCENT ELSDEN

Storrington, February 25

Palæolithic Man and Löss

I HAVE just been reading Geikie's "Prehistoric Europe," and am much interested by his digest of Dr. Nehring's discovery at Thiede and Westeregeln. At p. 150 it is stated that "the lower beds at Westeregeln have yielded traces of man such as flint flakes, charred wood, and heaps of smashed and crushed bones of various animals." And further on, "that they could not have come from any distance, an inference which is in keeping with the generally unrolled character of the stones and the state of preservation of the fragments of wood." At p. 151 he describes another interesting find by Count Wurmbrand near Zeiselberg. "At that place the undisturbed löss yielded a rich deposit of bones underneath which occurred a blackish stratum abounding with fragments of charcoal and worked flints." From the general appearance presented by the human relics and animal remains (mammoth, rhinoceros, reindeer, &c.) "it was evident that they could not have been transported from any distance."

An idea seems to be conveyed here that the remains in both cases had been carried by water and redeposited, but it appears to me that they have been found just where Palæolithic man left them. From the experience gained by eleven or twelve years' study of the sand-hills round the northern coast of Ireland and the finding of blackish layers containing flint flakes, implements, and broken bones of Neolithic age, I believe Dr. Nehring and Count Wurmbrand have hit on old land surfaces on which Palæolithic man lived; that the fragmentary bones have been scattered about by him after using the flesh for food; and that the unrolled stones can be accounted for by supposing that he carried them to the spots where they were found.

The blackish layers in the sand hills of the Irish coast, which I have found to contain flint flakes and implements, are covered with a great thickness of sand, and I have on several occasions expressed my opinion that this covering was accumulated slowly, first by the wind depositing the sand, and secondly by the grass retaining what it could shelter, the increase in thickness being dependent on the rapidity of vegetable growth. I first stated my views on this subject at the Belfast meeting of the British Association in 1874, and since in several published papers (see *Journal* of the Anthropological Institute, vol. vii. No. 3, and ix. No. 3; *Proceedings* Royal Irish Academy, 2nd series, vol. ii. No. 3). All the evidence given by Sir Charles Lyell in "The Antiquity of Man," and by Dr. Geikie in "Prehistoric Europe," in reference to loess (löss) clearly points to its being in its present condition an accumulation also produced by the joint agencies of wind and vegetation, and I have no doubt, from reading of Dr. Nehring's and Count Wurmbrand's finds, that during the slow and steady growth of the löss, many Palæolithic land surfaces and sites of camps or dwellings may have been buried up, and may now occasionally be found in an undisturbed state. Newer surfaces with included remains may also be found higher up, as in every stage the valleys would be the most desirable places to live in.

At p. 165 Dr. Geikie mentions a theory advanced by Baron Richthofen as to the formation of löss in China. I express no opinion as to the first production of the fine material, but as to its deposition by the wind afterwards, I believe he was on the right track. In the case of the sand-hills I have studied, the portions covered by grass are still becoming higher. Would it not be interesting to find out if the löss, in any protected part, is also increasing in thickness at the present time?

Cullybackey, Belfast, February 18 W. J. KNOWLES

Pronunciation of Deaf Mutes who have been Taught to Speak

THE letter of Prof. A. Graham Bell in NATURE (vol. xxv. p. 124) is hardly conclusive of the matter. The evidence he adduces, though exceedingly valuable, is chiefly of a negative character.

M. Hement states as a matter of his own personal observation, that deaf-mutes who have been taught to speak, do so with the accent of their native district. M. Blanchard denies this because, according to him, the pronunciation of deaf-mutes does not possess that quality of accent distinguishing human voices. Mr. Bell agrees with the conclusion at which M. Blanchard has arrived, but denies the data on which the conclusion is based. Mr. Bell, in an examination of at least 400 deaf-mutes, has never noticed the tendency observed by M. Hement. "It is true," he adds, "that in a few cases dialectic (? dialectal) pronunciations are heard, but it always turns out upon investigation that such children could talk before they became deaf. The peculiarity is undoubtedly due to the unconscious recollection of former speech, and cannot correctly be attributed to heredity." M. Hément, however, reaffirms the accuracy of his own observations, and declares himself unable to conceive how in losing the case of speech, deaf-mutes should retain the unconscious memory of accent.

Prof. Graham Bell's theory will certainly not explain the case of Daniel Fraser, referred to in my previous letter, who is expressly stated to have "continued deaf and dumb from his birth till the seventeenth year of his age (*Philosophical Transactions*, No. 312). This case is all the more striking since the narrator mentions his inheritance of the Highland accent in a purely incidental manner.

I am fully aware of the weight to be attached to the evidence of an observer so able, precise, and accurate as Prof. Graham Bell, but that he has *not* noticed the peculiarity in question can hardly be held to invalidate the independent testimony of those who, in Paris, Madrid, and Inverness, declare that they have observed it. For my part I see no reason to doubt either their accuracy or their good faith. E. A. AXON

Manchester

P.S.—It may be worth noting that the full discussion of the subject has appeared in the *Comptes rendus*, the current volume of which contains three notes by M. Hément, one by M. Blanchard, one by Mr. Bell, and one by the present writer.

A Strange Phenomenon

On February 18 this part of Scotland was visited by a furious gale of wind, rain, sleet, and hail. The gale subsided considerably about five o'clock in the afternoon. At eight o'clock the sky was fairly clear, when a black cloud sprang up in the north, and the night became suddenly intensely dark. With the darkness came a tremendous shower of hail. All at once I was startled by a vivid flash of lightning close at hand, but without thunder. At the same instant I found myself enveloped in a sheet of pale flickering white light. It seemed to proceed from every part of my clothes, especially on the side least exposed to the hail, and more particularly and brightly from my arm, shoulder, and head. Though I turned about pretty smartly, and shifted my position, I found it impossible to shake off the flickering flames. When I walked on they continued with me for two or three minutes, disappearing only when the violence of the blast was somewhat diminished. I felt no unusual sensation beyond the stinging of the hail, and no sound except that of the storm. Then and since I have puzzled myself to account for the strange phenomenon, and can only imagine it to have been a peculiar manifestation of St. Elmo's Fire, so well known to sailors during thunderstorms within the Tropics. Some of your readers may, perhaps, be able to give instances of a similar occurrence, unique both in my experience and reading.

James Moir

Schoolhouse, Savoch, Ellon, Aberdeenshire, N.B., Feb. 12

Intelligence in Birds

As it appears to me that in the correspondence to Nature on this subject no instance has been given of reasoning power in birds, more notable than that afforded by Miss Bird in "Unbeaten Tracks in Japan," I venture to submit the following quotation.

X.

February 15

"I have not said anything about the crows, which are a feature of Yezo, and one which the colonists would willingly dispense with. There are millions of them, and in many places they break the silence of the silent land with a Babel of noisy discords. They are everywhere, and have attained a degree of most unpardonable impertinence, mingled with a cunning and sagacity which almost put them on a level with man in some circumstances. Five of them were so impudent as to alight on two of my horses, and so be ferried across the Yurapugawa. In the inn-garden at Mori I saw a dog eating a piece of carrion in the presence of several of these covetous birds. They evidently said a good deal to each other on the subject, and now and then one or two of them tried to pull the meat away from him, which he resented. At last a big strong crow succeeded in tearing off a piece, with which he returned to the pine where the others were congregated, and after much earnest speech they all surrounded the dog, and the leading bird dexterously dropped the small piece of meat within reach of his mouth, when he immediately snapped at it, letting go the big piece unwisely for a second, on which two of the crows flew away with it to the pine, and with much fluttering and hilarity they all ate, or rather gorged it, the deceived dog looking vacant and bewildered for a moment, after which he sat under the tree and barked at them inanely. A gentleman told me that he saw a dog holding a piece of meat in like manner in the presence of three crows, which also vainly tried to tear it from him, and after a consultation they separated, two going as near as they dared to the meat, while the third gave the tail a bite sharp enough to make the dog turn round with a squeal, on which the other villains seized the meat, and the three fed triumphantly upon it on the top of a wall. In many places they are so aggressive as to destroy crops, unless they are protected by netting. They assemble on the sore backs of horses and pick them into holes, and are mischievous in many ways. They are very late in going to roost, and are early astir in the morning, and are so bold that they often came 'with many a stately flirt and flutter' into the verandah where I was sitting. I never watched an assemblage of them for any length of time without being convinced that there was a Nestor among them to lead their movements. Along the seashore they are very amusing, for they 'take the air' in the evening, seated on sandbanks facing the wind, with their mouths open. They are threatening to devour the settlers, and a crusade is just now being waged against them, but their name is Legion." ("Unbeaten Tracks in Japan," vol. ii. p. 149.)

A System of Meteorological Observations in the China Seas

In Nature (vol. xxv. p. 368) you give information about a system of observations and storm-warnings about to be started in the China seas. The scheme itself is excellent, and the choice of Zi-ka-wei (not Siccawei) is also good, only I may express a doubt as to the success of the storm-warnings till a greater area is included. As to the *winter-storms*, some stations in the north-west of China are necessary, and even Kiakhta and Irkutsk would be more useful than Vladivostok, for example, as depressions coming from the west will be earlier felt there than in China. As to the *typhoons*, as they certainly originate east from China, and first travel to the west, telegraphic warnings from Formosa and the Liu-kiu islands would be necessary, otherwise they are apt to reach the coast of China too suddenly. With a chain of stations on these islands between China and Japan it would be possible to observe typhoons at or very near to their origin, to follow them step by step, and save an immense quantity of life and property. A telegraph line uniting these islands to China and Japan is certainly a large undertaking, but as the Japanese will derive great benefit from it, they will probably take part of the expenses.

A. Woeikof

St. Petersburg, February 23

New Red Star

The following is a rather noteworthy case of fine red colour in a very small star. It was observed February 7 and 8 as follows:—

R.A. 4h. 59m. 41s.; Dec. $-22°\ 3'$ (1880) mag. 9·5.

It is 29′ north and 41s. west of ϵ Leporis.

Edward S. Holden

Washburn Observatory, University of Wisconsin,
Madison, Wisconsin, February 8

Purification of Sewage

In the purification of sewage by the methods of irrigation and filtration it is said that filtration through a depth of ten inches of soil suffices to get rid of the phosphates, may I ask if it is known through what depth of soil it is necessary to filter to eliminate the nitrates?

X.

February 14

THE INTERNATIONAL FISHERIES EXHIBITION

At last the great International Fisheries Exhibition, to be held in London, and to which we have occasionally referred during the past few months, has taken definite shape. The influential meeting which was held on Monday under the presidency of the Prince of Wales, gives promise that the Exhibition will be one of the most interesting and practically important which have been held in the country. The Berlin exhibition last year was a brilliant success, and the Norwich Exhibition of last spring did much good. Her Majesty the Queen has bestowed her name as patron on the proposed Exhibition; the Prince of Wales is president, and on the long list of Vice-presidents are many nobles, politicians of both parties, well-known representatives of science, and men eminent in various departments. Of the General Committee, the Duke of Richmond is Chairman, and on it are such names as those of Prof. Huxley, Mr. Spencer Walpole, Mr. Francis Francis; while among the Vice-presidents are the names of Mr. W. Spottiswoode, P.R.S., Dr. Günther, Sir John Lubbock, Mr. Mundella. Thus it will be seen that science is amply represented, and especially the science of the subject; and it is fortunate that we have at present as one of H.M. Inspectors of Fisheries so eminent a representative of science as Prof. Huxley.

The project of holding an International Fisheries Exhibition in London is, in a great measure, the result of the success of the National Fisheries Exhibition held in April, 1881, at Norwich, under the patronage of H.R.H.

the Prince of Wales, and under State recognition, with the co-operation of the Worshipful Company of Fishmongers. At a private meeting held in July, 1881, it was determined by a few leading gentlemen, interested in the welfare of the great fishing industries, to follow up the National Fisheries Exhibition at Norwich by calling a public meeting in order to discuss the desirability of holding an International Fisheries Exhibition in London in 1883. A meeting was accordingly held at Fishmongers' Hall in August, 1881, under the presidency of the Marquis of Exeter, and Resolutions were unanimously passed approving the idea as likely to be of the greatest benefit and importance to fishing industries throughout the world. A General and Executive Committee were then formed, and great progress has since been made in preliminary arrangements.

The Committee, we are assured, have bestowed long and anxious consideration on the prospectus of the proposed Exhibition. The classification, which has been compiled with the assistance of leading scientific men, comprises every object adapted for exhibition, illustrative of Sea and Fresh Water Fisheries; the preparation, preservation, and utilisation of Fish; Fish Culture; the Natural History of Fish, and Literature connected with Fishing. It is proposed to give prizes on important subjects connected with fishing; and, with a view of turning the Exhibition to practical account, conferences are to be held for the purpose of reading and discussing subjects specially connected with the fishing industries. The Exhibition is to be opened on the 1st of May, 1883. In order to illustrate the great extent and magnitude of the fishing industries of the United Kingdom, it may be stated that, at the lowest calculation, 550,000 tons of fish are annually taken in British waters by our own fishermen; that, according to Professor Huxley, 3,000,000,000 herrings are annually taken in the North Sea alone; that 130,629 tons of fish were delivered in Billingsgate Market in one year; and that the fisheries of the United Kingdom are carried on by about 35,000 boats and vessels, giving employment to no less than 110,000 people afloat.

To carry out the proposed Exhibition on an adequate scale, it is proposed to open immediately a subscription list for the general and prize fund, and also a subscription list for a guarantee fund, to provide against contingent liabilities in the event of the proceeds of the Exhibition proving insufficient to meet the expenditure. The Fishmongers Company have already promised the sum of 500*l.* for the general and prize fund, and 2,000*l.* to the guarantee fund.

The Exhibition will be divided into seven classes, each with many subdivisions:—I. Fishing, in two sections, Sea Fishing and Freshwater Fishing; II. Economic Condition of Fishermen; III. Commercial and Economic; IV. Fish Culture, which will include sections devoted to Scientific Investigation and Acclimatisation of Fish; V. Natural History under the following departments:—1. Specimens living (marine and fresh water), fresh, stuffed or preserved, casts, drawings and representations of—(*a*) Algæ arranged according to their various species and localities; (*b*) Sponges, in their natural state; (*c*) Corals, in their natural state, polyps, jelly-fish, &c.; (*d*) Entozoa; (*e*) Mollusca of all kinds and shells not included in class III.; (*f*) Starfishes, sea urchins, holothuriæ; (*g*) Worms used for bait, or noxious; leeches, &c.; (*h*) Perfect insects and larvæ of insects, which are destroyers of spawn or serve as food for fish; (*i*) Crustacea of all kinds; (*k*) Fish of all kinds; (*l*) Reptiles, such as tortoises, turtles, terrapins, lizards, serpents, frogs, newts, &c.; (*m*) Aquatic and other birds hostile to fish or fishing; (*n*) Aquatic and amphibious mammalia (otters, seals, whales, &c.) and others detrimental to fish. 2. Works on Ichthyology. Maps illustrating geographical distribution, migration, &c., of fishes and spawn. 3. Specimens and representations illustrative of the relations between extinct and existing fishes. VI. History and literature of fishing, fishing laws, fish commerce. VII. Loan collections. This certainly seems comprehensive enough.

According to a preliminary notice Prizes of 100*l.* will be given for each of the following subjects, viz.:—1. The natural history of commercial fishes of Great Britain, with especial reference to such parts of their natural history as bear upon their production and commercial use. 2. Relations of the state with fishermen and fisheries, including all matters dealing with their production, regulations, &c. 3. On the possible increase of the supply of fish, and on improved facilities for their economic transmission and distribution.

All the speakers at Willis's Rooms on Monday seemed duly impressed with the importance of the Exhibition; and it was evident from their speeches that the Prince of Wales and Duke of Edinburgh take a genuine and intelligent interest in the matter. The statistical and economical sides of the proposed Exhibition were naturally more prominent before the meeting than the scientific, though the composition of the committee is a guarantee that the latter will have full attention. The Prince of Wales's reference to Prof. Huxley, and the plan of exhibits given above, may be taken as significant that these will not be neglected. There is plenty of time to make all arrangements and find a proper *locale*, and, probably enough, the committee may find it necessary to make some modifications in their arrangements. We are glad to see that the Prince of Wales is acquainted with the important work in fish-culture which is being done in the United States, which, we trust, will be fully represented at the Exhibition.

It may be useful to our readers to know that the offices of the Exhibition are at 24, Haymarket.

THE CHEMISTRY OF THE ATLANTIC[1]

II.

IN considering the effect of depth on the gaseous contents of sea water, Dr. Tornoe arranges his results in groups, giving the mean percentage of oxygen in different intervals of depth. From the consideration of this table he concludes that "the proportion of oxygen, which at the surface is 35·3 per cent., begins at once and continues to diminish, at first rapidly and afterwards at a slower rate, till it has reached 32·5 per cent. at the depth of 300 fathoms, from whence it keeps almost constant. I will not omit, however, to observe that of the samples of water examined, forty had been drawn from the bottom; it was, however, impossible to detect any difference in composition between these and the samples obtained from equal intermediate depths."

The results of the analysis of the *Challenger* samples pointed to a very decided minimum of oxygen occurring about 300 fathoms from the surface. The observations on which this conclusion depended were the analyses of the gases from two samples of water from 300 fathoms in the region of equatorial calms in the Atlantic. The temperature of the water was 7·0° C. and 6·8° C., and the oxygen percentages 10·75 and 11·98. The nearest part of the ocean where a surface temperature of 7° C. occurs at any time of the year is more than 2000 miles distant, so that the water in this position must necessarily have been shut out from a fresh supply of oxygen for a long time while continually exposed to the reducing action of live and dead animal matter. In the Arctic waters explored by the Norwegian Expedition there must be a tolerably thorough equalisation of temperature from surface to bottom every winter, producing a renewal of the atmospheric contents of the water, consequently it is not surprising that the

[1] The Norwegian North Atlantic Expedition, 1876-78. Chemistry. By Hercules Tornoe. (Christiania: Grœndal and Son, 1880.) Continued from p. 389.

differences observed both by the Norwegian Expedition and by Jacobsen in the aëration of water from different depths are so slight. Indeed, the *Challenger* analyses show exactly the same result for Antarctic waters. As the amount of nitrogen is probably not exposed to diminution, it may be taken as an indication of the temperature at which the water was last exposed to the air, and may therefore be used as a check on the depth from which the water has been brought, more especially in tropical regions, where the temperature at the surface is very different from what it is either at the bottom or intermediate depths. For this purpose, however, we require more observations on the absorption of atmospheric gases by sea water, especially at low temperatures; and, further, any conclusions drawn must be inaccurate, in so far as we do not know the barometric pressure of the atmosphere to which the water has been exposed. This is a very important element, for the water at the surface of the Antarctic Ocean is exposed to a much lower mean barometric pressure than at any other part of the globe, whether Arctic, Temperate, or Tropical, consequently a carefully-made determination of the nitrogen in a bottom water would, when taken in connection with the temperature, indicate whether it came from Arctic or Antarctic sources. This difference would certainly amount to 1 cc. per litre, which could easily be determined with careful work.

The great value of the results obtained by Dr. Tornoe in this department of his work make it all the more to be regretted that through mechanical mishaps so many samples, involving much time and work, should have been lost.

The form in which the results are presented to the reader might be improved by the addition of one or two columns to the table. It includes the analyses of samples collected in the three summers, 1876, 1877, and 1878, and it would have been more useful to the reader to have found the date of collection in the first column than a series of consecutive numbers. The second column is the "Station No.," and it is important as facilitating reference to other results obtained at the same place. By its means the writer was enabled to refer to Prof. Mohn's papers in *Petermann's Mittheilungen*, and from them to supply a column giving the depth of the sea at the station. The omission of this information from the table made it impossible to distinguish between bottom water and water from intermediate depths. Another column might also with advantage have been added, giving the volume of oxygen in cubic centimetres per litre.

In the second chapter of the work Dr. Tornoe treats of the carbonic acid dissolved in sea-water, and here also he adds very materially to our knowledge. The first reliable information on the subject was obtained by Jacobsen on board the *Pomerania*. He rejected the gasometric method, having recognised the uncertainty which attached to the elimination of the carbonic acid from sea water by boiling under reduced pressure and adopted the method of determining the carbonic acid directly, as soon as the sample of water was brought on board, by boiling it down nearly to dryness, and drawing a current of air through it, which conveyed the steam and carbonic acid into a suitable receiver charged with baryta water. In the *Challenger* substantially the same method was employed, with this important addition, that an excess of a saturated solution of chloride of barium was added to the water before distilling. By precipitating the sulphates, their effect in reducing the tension of the carbonic acid was destroyed, and also the liquid was got into a condition in which it boiled calmly, without bumping, until almost quite dry. The object aimed at was the determination of the carbonic acid present in the water in the free or *half-bound* state, to the exclusion of that present as neutral carbonate. There is no doubt that this was successfully accomplished, and the experiments made by Dr. Tornoe furnish satisfactory evidence. "In order to ascertain whether the decomposition by boiling of the neutral carbonates in sea-water also took place to a considerable extent when insoluble sulphates were present in that fluid, I made a few experiments by Buchanan's process. From several samples of sea-water, which, examined by the method I adopted, were found to contain 96 mgr of carbonic acid per litre, I succeeded, by evaporation to dryness, after adding a solution of chloride of barium, in liberating about 50 mgr. only, with a solitary exception, when the amount exceeded 50 mgr. per litre. The proportion of carbonic acid expelled was accordingly not much greater than that determined by Buchanan in water from equatorial seas, and but a few milligrammes in excess of what the carbonic acid forming bicarbonates, according to trustworthy observations, should have been; of the carbonates said to be present in the residue I failed to detect any trace." This experiment shows that what was sought was really obtained, namely, the determination of the carbonic acid *not* present as neutral carbonate.

The method finally adopted by Dr. Tornoe is an exceedingly ingenious one, and has the great advantage of giving both the free and the bound carbonic acid. It consists in adding to the sample of water a measured quantity of acid of known strength, driving off the liberated carbonic acid by gentle heating, and collecting it in baryta water of known strength. When the operation is finished, the excess of acid in the boiling flask and the excess of alkali in the receiver are separately determined. The amount of baryta neutralised gives the total carbonic acid, while the amount of acid neutralised gives the amount present as neutral carbonate.

It does not seem to have occurred to Dr. Tornoe that his method of determining the carbonic acid might be combined with the boiling out of the oxygen and nitrogen. If to the sample from which the gases are to be extracted by boiling under reduced pressure be added sufficient acid to more than neutralise the carbonates, and the boiling be then continued as if for the elimination of the oxygen and nitrogen, the whole of the carbonic acid should be obtained along with these gases, while the excess of acid in the flask could be measured when the operation was finished. This process would have the advantage that oxygen, nitrogen, and carbonic acid would be collected in one operation. It would be necessary to make the tube in which the gases are to be preserved larger than is at present usual, but a volume of 100 cubic centimetres would suffice for a volume of 800 or 900 cubic centimetres water.

By this method the carbonic acid was determined in seventy-eight samples of water from different parts. It is somewhat of a pity that the determinations were not made on board when the samples were fresh, though there is no doubt that in the case of sea waters which contain only traces of organic matter, the amount of carbonic acid is not sensibly affected by keeping. The results obtained are very uniform, and he gives the following average formulæ:—

$$52{\cdot}78 \pm 0{\cdot}83 \text{ mgr. per litre}$$

for the carbonic acid forming carbonates with a probable error in a single observation of $\pm$ 0·662 per litre; and

$$43{\cdot}64 \pm 0{\cdot}16 \text{ mgr. per litre}$$

for the carbonic acid, forming bicarbonates with a probable error in a single observation of $\pm$ 1·26 mgr. per litre."

Touching the uniformity of these results, it must be observed that the samples would probably be all at nearly the same temperature when examined, while they would be collected at different and lower temperatures. Hence the fact of keeping would tend to produce uniformity in the results. Hence also there is no mention of temperature in his average formulæ. Now although the law regulating the absorption of carbonic acid by sea water at

different temperatures cannot be precisely stated, the *Challenger* results leave no doubt that more carbonic acid is absorbed the lower the temperature is. Taking the mean of all the *Challenger* determinations in surface water at temperatures between 10° C. and 15° C., we have 43·5 mgr. per litre of carbonic acid liberated by boiling to nearly dryness after precipitation of the sulphates; and this agrees to a fraction of a milligram with Tornoe's average amount of carbonic acid present as bicarbonate.

Dr. Tornoe concludes this part of the work with an interesting inquiry into the condition in which the carbonic acid exists in the water, and comes to the conclusion that it is probably present in combination with soda, forming bicarbonate of soda.

In the third portion of his work Dr. Tornoe gives an account of his experiments on the amount of salt held in solution by the sea water. For determining it he follows two methods, the one depending on the specific gravity, and the other on the chlorine contained in the water. The specific gravity was determined by means of suitable glass hydrometers, and the chlorine by means of silver solution of known strength. In order to reduce the specific gravities which were observed at various temperatures to their value at one standard temperature, Dr. Tornoe reports an elaborate series of experiments on the expansion of sea water due to change of temperature, and he uses the results so obtained along with those of Ekman for reducing his results. They are given in two columns; in the one is the specific gravity at 17·5° C. referred to that of distilled water at the same temperature as unity; in the other they are reduced to their value at the temperature of the water when *in situ*, referred to distilled water at 4° C. as unity.

In order from these results to arrive at a knowledge of the amount of solid matter dissolved, he makes a series of careful determinations of solid residue of chlorine and of specific gravity in seven samples of water. He finds that "the co-efficient of chlorine may be taken at—

$$1{\cdot}809 \pm 0{\cdot}00076$$

with a probable error in a single determination of ± 0·002, and the co-efficient of specific gravity at—

$$131{\cdot}9 \pm 0{\cdot}058$$

with a probable error in a single determination of ±0·15." The specific gravity is here taken at 17·5° C., and the unit is that of distilled water at the same temperature.

The determination of the solid residue in sea-water presents special difficulties due to the presence of so large amounts of magnesia salt. These difficulties are overcome in an ingenious way:—"From 30 gr. to 40 gr. of sea-water were introduced into a thick porcelain crucible of known weight furnished with a tight-fitting cover, and evaporated on a water-bath. So soon as the salt was sufficiently dry the crucible with the cover on was heated for about five minutes over one of Bunsen's gas-burners, then cooled and weighed with its contents."

The free magnesia liberated by this process was then determined by dissolving the salt and adding a quantity of titrated sulphuric acid and determining what remained unneutralised by titrating with caustic soda.

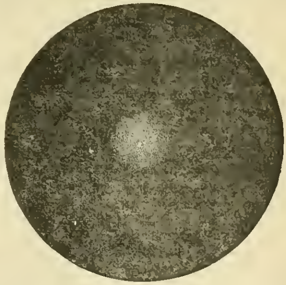
The results so obtained are given in a table, and also represented graphically in charts at the end of the work. These charts show very clearly the distribution of the water from the Atlantic amongst that coming from Polar regions, which is also confirmed not only by the temperatures observed, but also by the distribution of nitrogen dissolved in the bottom water, of which Dr. Tornoe has given a chart. It is well known that the water coming up from the North Atlantic is much salter than that coming south from the Arctic and Polar regions. From the variations in the amount of salt found in the bottom water of different districts Dr. Tornoe suspected that some of it must be due to the presence of Atlantic water which had got cooled on its way north, and had sunk to the bottom. It is in the highest degree probable that the nitrogen found dissolved in a sea-water, taken from any depth, is the nitrogen which it took up when last exposed to the atmosphere. Now the amount of nitrogen which it would take up would depend to a great extent on the temperature, so that water which had been exposed at the surface in Arctic regions would take up more nitrogen than water which had been exposed in temperate regions, so that the amount of nitrogen present, for instance, in a bottom water, may be taken to indicate the temperature which the water had when last exposed to the atmosphere. Now it is a remarkable result of Dr. Tornoe's investigations that where he finds a high percentage of salt in the bottom water he also finds a low percentage of nitrogen, and *vice versâ*, rendering it in every way probable that the areas which he has mapped out are really supplied on the one hand from the Atlantic, and on the other from the Arctic Oceans. This result is a further evidence of the importance of accurate determinations of the gaseous contents of sea-water.

It is impossible to conclude this notice without congratulating the Norwegian nation on the advanced position which it has taken up in ocean exploration and the success which has attended the labours of its servants, and in an especial way of Prof. Mohn and those associated with him in the three summer trips of 1876, 1877, and 1878. Not only is the work done great in amount and of the highest scientific interest, but it has been published with a praiseworthy expedition which adds immensely to its present value.

J. Y. Buchanan

COMET *f* 1881

On the morning of October 4, 1881, while engaged in sweeping the eastern sky for new comets, I found an object about 10 degrees preceding α Leonis on the ecliptic which bore a strong resemblance to a bright round nebula, with a marked condensation in the centre. I roughly estimated the position of the object, and referring to Herschel's catalogue of nebulæ, endeavoured to identify it, but without success. Then carefully noting its place relatively to the small stars in the same field of my



Comet *f* 1881, October 3, 15h. 15m.; 10-inch reflector, power 25.

10-inch reflector, I resumed sweeping in the region near. About half an hour later—3 45 a.m.—I re-observed the object, as clouds were rapidly coming up. A slight motion to the eastward was at once suspected to have occurred in the interval, but my positions were merely eye estimations, and I distrusted them though feeling certain at the time that the supposed displacement was real. I had only obtained a momentary glimpse when the sky became completely overcast, but fortunately the ensuing night was cloudless, and I was enabled to obtain another observation. The suspected object did not rise until soon after 1 a.m., and I knew that it would not come under the

range of my 10-inch reflector before about 2h. 30m. a.m. Apart from this, the moonlight was very troublesome. Adjusting the telescope I immediately saw the small stars of the preceding night, but the nebulous object had disappeared though it was found directly afterwards in a place about half a degree east of its position on the previous morning. The true character of the object thus became unmistakeable. It was a telescopic comet with an apparent motion towards the sun, though really the distance between the two bodies was daily becoming greater, owing to the fact that the sun's apparent motion eastwards along the ecliptic was about twice as great as that of the comet.

Information of the discovery was telegraphed to Greenwich and Dun Echt, and subsequently the Astronomer-Royal sent notification to some of the chief foreign observatories. Coggia at Marseilles, the discoverer of the great comet of 1874, picked up the new comet on the night (October 5) following the receipt of the telegram, and on October 9 it was observed by Messrs. Lohse and Copeland at Dun Echt. But at Harvard College Observatory (U.S.) it was looked for in vain, for the comet managed to elude detection until a special message had been dispatched from Lord Crawford's observatory, giving its accurate place, when it was ultimately found by Mr. Wendell. It was observed at the latter station on the nights of October 10 and 11, and the positions obtained then, in combination with a Dun Echt place of October 9, enabled Mr. Chandler to compute approximate elements, from which it appeared that the comet was receding both from the earth and the sun, and the orbit presented some resemblance to that of the comets of 1819 IV. and 1771 I. Parabolic elements were subsequently computed by Messrs. Copeland and Lohse, by Dr. Oppenheim at Vienna, J. Palisa at Wien, and by Mr. J. R. Hind at London. It soon became evident however that an elliptical orbit would best satisfy the later observations, and M. L. Schulhof at Paris was the first to compute them, using the Marseilles position of October 5, Dun Echt October 9, and Paris October 18. He gave the period as $7\frac{3}{4}$ years, though admitted that a considerable amount of uncertainty was attached to this result. Elliptic elements were also computed by Prof. Winnecke at Strassburg, by Mr. S. C. Chandler at Boston (U.S.), and by Herr Block at Odessa, the resulting periods being 8·407 years, 8·343 years, and 9·106 years respectively. Schulhof also reconstructed the orbit on the basis of many later positions, and deduced the period as 8·45 years, which is in very close agreement with the results of Prof. Winnecke and Mr. Chandler. The following are the elements as computed by Messrs. Schulhof and Winnecke respectively:—

Perihelion Passage, Sept. 13·25866 Berlin mean time.

Longitude of perihelion	=	312° 21′ 0″·4
Longitude of node	=	65 57 50·0
Inclination	=	6 51 36·2
ϕ	=	55 37 25·8
log. q	=	9·860192
log. e	=	9·916637
log. a	=	0·618020
Period	=	8·45 years.

Perihelion Passage, Sept. 13·1697 Berlin mean time.

Longitude of perihelion	=	312° 11′ 22″
Longitude of node	=	66 4 2
Inclination	=	6 52 36
ϕ	=	55 34 7
log. q	=	9·859955
log. a	=	0·616427
Period	=	8·4072 years.

Herr Block finds the period 9·106 years, and remarks (*Science Observer* Circular, No. 21) that "the orbit of the comet is similar to the orbits of comets 1743 I. and 1819 IV., which Prof. Clausen supposed to be identical (*Ast. Nach.* x. p. 363), but, in this case, the time of revolution should be nearly 7·7 years. The orbit is also similar to the orbit of the comet of 1585, excepting that the perihelion distance is very different. Supposing that there were 17 revolutions between 1585 and 1743, and 15 revolutions between 1743 and 1881, the time of revolution would be 9·252 and 9·253 years. The comet of 539 also accords with the period of 9·25 years."

M. Schulhof says that the period may possibly be larger than that assigned in his elements, as there are deviations in the middle places of the orbit seeming to suggest such a conclusion. It is explained in *Science Observer*, No. 35, p. 94, that this comet approaches nearer to the earth than any other, except that of Biela, of whose continued existence we are becoming very sceptical. It is singular that the new comet evaded discovery so long, for it must have been a conspicuous object in the southern hemisphere in August, for on the 18th of that month it was "within 11,000,000 miles of the earth, and its brilliancy equal to forty or fifty times that at discovery, and in fact easily visible to the naked eye."

The last observation of this new periodical comet was made, I believe, by Prof. Winnecke on November 19 with the 20-inch refractor at Strassburg Observatory, when the position was α = 10h. 40m. 32·92s., δ = 14° 49′ 30″·7 N. at 16h. 46m. 38s. Strassburg mean time.

As this comet approaches somewhat near to the earth, the idea occurred to me that it might very possibly be associated with one of the numerous meteor streams which I had observed during the few preceding years, but the theoretical radiant point of the comet is a southerly one, and is so near the sun that the chances of its observation are very meagre. Prof. Herschel computes that the earth passes the comet's ascending node on November 28, when the radiant point of any meteors following the orbit of the comet would be at R.A. 272°, Dec. 37° S., which is near ϵ Sagittarii, and 29° south—following the sun's place. The meteor speed would be = 14 miles per second, but the shower could only be observed in the early evening, inasmuch as the radiant sets about half an hour after the sun. On December 14 the cometary orbit passes + ·033 N. of the earth's orbit, and the radiant point is at α 277°, δ 34° S., but in this case also a shower of meteors proceeding from the comet would be invisible, because the radiant sets with the sun.

A good deal has been said with reference to the supposed resemblance of orbit between this comet and Blanpain's (1819 IV.), but if they are identical the orbit and period have undergone remarkable changes since 1819, and the question cannot be definitely settled until the perturbations arising from the action of Jupiter have been investigated. It must be admitted that some comets, as for example Lexell's, have been drawn into new orbits by planetary influence, and it is possible that the cumulative effects of this may have brought about a lengthening of the period in the present case, for the period of Blanpain's comet, as computed by Encke, was only 4·81 years, which is not considerably more than one-half that of the new periodical comet. Whether the latter will return at its predicted epoch in 1890 is open to some conjecture, but a careful investigation of the orbit and of the perturbations which must affect it in the interval, will to a great extent remove the difficulties. The comet is evidently a bright one, and in certain positions will be presented as a conspicuous object, so that it may have been frequently observed during former returns to perihelion, though the great variations in its orbit originated by perturbation, make it difficult to reconcile the orbital elements at different returns. The comet may also have often escaped discovery at its re-appearances similarly to the periodical comets of Encke and others, which must manifestly increase the difficulty of fixing with any degree of certainty the epochs of its former apparitions. It is, however, satisfactory that the comet at its recent return was fairly well

observed, and its elliptical elements having been computed on several hands with marked consistency, we may assume that its present form of orbit is known with considerable accuracy. W. F. DENNING

THE MAKING OF ENGLAND[1]

IN an instructive article in *Macmillan's Magazine* for this month, Prof. Geikie shows what important influences the geological development of our country has had upon its history. Prof. Geikie begins in long past prehistoric times, when England formed part of the European continent, and rapidly traces the changes which have gone to make England what it is; shows the bearing which the physical geography of the country had on the settlements of the early inhabitants, pre-Aryan and Aryan, and in later times on the development of England's commerce, and the growth of her greatness. What Prof. Geikie does for England as a whole Mr. Green attempts to do for "Anglo-Saxon" England, for that England which was destined to form the broad basis of the England of the present day. Mr. Green, in his well-known "History of England," as we pointed out at the time of its publication, made some attempt to take account of the physical conditions of our country in so far as they have influenced her history; and this is essentially the method he followed in his valuable text-book of British Geography. Hitherto historians have taken little or no account of the environment of nations, although it is evident that that must be a factor of the first importance in determining the character of a people and their historical development. In a general way every one must admit that the climate and physical condition of a country have their influence on the character of a people; but in its strictly scientific aspect the subject is yet in its infancy, and we hope that Mr. Green's example will encourage others, both historians and scientific geographers, to work it out thoughtfully and minutely. It is not our province to examine Mr. Green's work critically, as an historical treatise; we shall leave it to others to say whether all his statements and inferences are authorised by the documents on which they are based. But that the work is full both of interest and instruction every one must admit. Mr. Green's geographical and topographical instincts are unusually keen, and his faculty for clothing the dry bones of chronicles, and antiquarian discoveries, and ethnological data with living flesh and blood is probably unsurpassed. In a series of pictures he brings before us our Teutonic forefathers with a vivid force that has all the interest and excitement of reality. We see them hovering off the shores of England, even while the Romans were in possession, watching their opportunity to pounce down upon the prosperous towns and homesteads; we see them at last get a firm footing, south and east and north, holding the coast regions with comparative ease, but baffled for years by the primeval forests and thick underwood, the widespread marshes and impassable rivers. Not for at least two centuries were they able quite to overcome these obstacles, and these, with the other physical features of the country, determine the relative positions ultimately occupied by Jute, Angle, Saxon, and Celt. With regard to the last-mentioned, Mr. Green, from a study of the finds in the Settle and other caves, is able to bring before us a touching picture of the flight of the Celtic men, women, and children with what utensils and ornaments they could carry with them before the advance of the ruthless Saxon.

"The hurry of their flight may be gathered from the relics their cave-life has left behind it. There was clearly little time to do more than to drive off the cattle, the swine, the goats, whose bones lie scattered round the hearth fire at the mouth of the cave, where they served the wretched fugitives for food. The women must have buckled hastily their brooches of bronze or parti-coloured enamel, the peculiar workmanship of Celtic Britain, and snatched up a few household implements as they hurried away. The men, no doubt, girded on as hastily the swords whose dainty sword-hilts of ivory and bronze still remain to tell the tale of their doom, and hiding in their breast what money the house contained, from coins of Trajan to the wretched 'minims' that told of the Empire's decay, mounted their horses to protect their flight. At nightfall all were crouching beneath the dripping roof of the cave or round the fire that was blazing at its mouth, and a long suffering began in which the fugitives lost year by year the memory of the civilisation from which they came. A few charred bones show how hunger drove them to slay their horses for food; reddened pebbles mark the hour when the new vessels they wrought were too weak to stand the fire, and their meal was cooked by dropping heated stones into the pot. A time seems to have come when their very spindles were exhausted, and the women who wove in that dark retreat made spindle whorls as they could from the bones that lay about them."

Then, when the invader has settled down in his conquests, the author restores to us with the broadness of reality, partly with material obtained by the researches of the archæologist, their mode of life, the nature and disposition of their *tuns* or settlements, the life of earl, ceorl, labourer, and slave, and to show us in the town *moot* the germs of our modern complicated parliament.

Mr. Green has evidently taken the greatest pains to master the physical geography and the great topographical features of the country at the landing of the Teutonic invaders. It was in many respects as different as possible from the surface with which we are at present familiar. The New Forest, Cranbourne Chase, and other scanty forests are but the remains of what at that period was almost one universal forest, impenetrable to all but natives, thickly clothed with underwood, and from which the great chalk-ranges rose, and provided almost the only settling-places of the inhabitants. Nowadays we find all our great cities along the river valleys or the coast; then the uplands were the only areas on which the inhabitants could settle, the marshy and wood-grown banks of the rivers being all but uninhabitable.

"It was not merely its distance from the seat of rule or the later date of its conquest that hindered the province from passing completely into the general body of the Empire. Its physical and its social circumstances offered yet greater obstacles to any effectual civilisation. Marvellous as was the rapid transformation of Britain in the hands of its conquerors, and greatly as its outer aspect came to differ from that of the island in which Claudius landed, it was far from being in this respect the land of later days. In spite of its roads, its towns, and its mining-works, it remained, even at the close of the Roman rule, an 'isle of blowing woodland,' a wild and half-reclaimed country, the bulk of whose surface was occupied by forest and waste. The rich and lower soil of the river valleys, indeed, which is now the favourite home of agriculture, had in the earliest times been densely covered with primæval scrub; and the only open spaces were those whose nature fitted them less for the growth of trees, the chalk downs and oolitic uplands that stretched in long lines across the face of Britain from the Channel to the Northern sea. In the earliest traces of our history these districts became the seats of a population and a tillage which have long fled from them as the gradual clearing away of the woodland drew men to the richer soil. Such a transfer of population seems faintly to have begun even before the coming of the Romans; and the roads which they drove through the heart of the country, the waste caused by their mines, the ever-widening circle of cultivation round their towns, must have quickened this social

[1] "The Making of England." By John Richard Green, M.A., LL.D. Maps. (London: Macmillan and Co., 1881.)

change. But even after four hundred years of their occupation the change was far from having been completely brought about. It is mainly in the natural clearings of the uplands that the population concentrated itself at the close of the Roman rule, and it is over these districts that the ruins of the villas or country houses of the Roman landowners are most thickly scattered."

As an instance of how Mr. Green is able to throw ligh

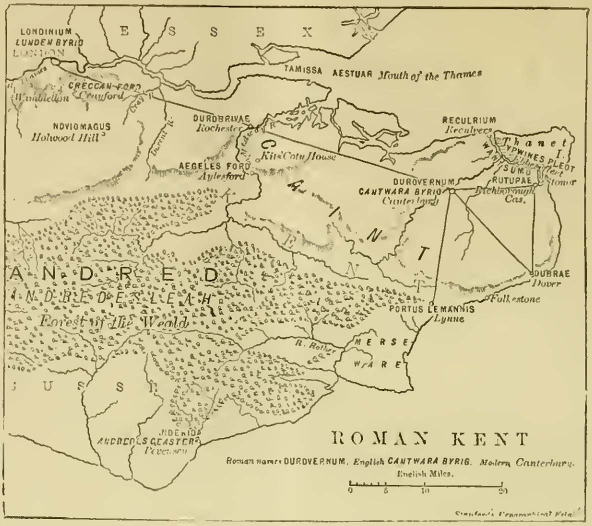


FIG. 1.

upon the progress of the Saxon conquest by his mastery of the physical condition of the country at the time, we quote another passage referring to the settlement of the Jutes. After describing the advance into the Caint (Kent) of the band under Hengest, Mr. Green goes on :—

"With this advance to the mouth of the Weald the

FIG. 2.

work of Hengest's men came to an end; nor did the Jutes from this time play any important part in the attack on the island, for their after-gains were limited to the Isle of Wight and a few districts on the Southampton Water. Fully indeed as the Caint was won, no district was less fitted to serve as a starting-point in any attack on Britain

at large. While the Andredsweald, which lay in an impenetrable mass along its western border, extended southward behind the swamps of Romney Marsh to the coast of the Channel, a morass that stretched from the hills of Dulwich to the banks of the Thames blocked the narrow strip of open country between the northern edge of the Weald and the river. The mere tempting waterway along the Thames itself was barred by the walls, if not by the fortified bridge, of London. The strength of these barriers is proved by the long pause which took place in the advance of the Jutes, for a century was to pass before they made any effort to penetrate further into the island" (Fig. 1).

Again the advance of the East Saxons was hindered by obstacles quite as formidable as the Andredsweald in South Britain. "As the South Saxons were prisoned within their narrow strip of coast by the reaches of the Andredsweald, so the East Saxons found themselves as effectually barred from any advance into the island by a chain of dense woodlands, the Waltham Chace of later ages, whose scanty relics have left hardly more then the names of Epping and Hainault Forests. These woodlands, which stretched at this time in a dense belt on either side the Roding along the western border of the district that the invaders had won from the Thames to the open downs above Saffron Walden, and were backed to the west by the marshy valley of the Lea, whose waters widened into an estuary as it reached the Thames, seem to have been wholly uninhabited, for no trace remains in their area of military stations or of the country houses or burial-places of the provincials. How impassable in fact these fastnesses had been found by the Romans is clear from the fact that even their road-makers never attempted to penetrate them. The lower portion of the Ermine Street, the road to the north, which in later days struck direct through this district from London to Huntingdon, did not exist in Roman times, and the British provincial was forced to make a circuit either by Leicester or Colchester on his way to Lincoln and York."

Further north again the progress of the Angles

EARLY LONDON.
(Local names around of later date.)

Fig. 3.

in what was known afterwards as East Anglia, and further north still in modern Lincolnshire, was naturally influenced by the widespread marsh, the remains of which are still to be seen in the Fen country. "We have seen what barriers held back the Jute of Kent and the Saxon on either side of him; but barriers as impassable held back the Engle of the eastern Gwent, for the forest-line which began on the Thames reached on along their western frontier to the Wash, and the Wash stretched to the northward from Newmarket to the sea. The fens which occupied this huge break in the eastern coast of Britain covered in the sixth century a far larger space than now; for while they stretched northward up the Witham almost as far as Lincoln, and southwards up the Cam as far as Cambridge, they reached inland to Huntingdon and Stamford, and the road between those places skirted their bounds to the west. So vast a reach of tangled marsh offered few temptations to an invader; and we shall see grounds at a later time for believing that the Gyrwas, as the Engle freebooters who found a home in its islands called themselves, were for a long time too weak to break through the line of towns that guarded its inner border" (Fig. 2).

One of the most interesting passages, with its accompanying map, in Mr. Green's book, is that in which he describes the probable founding of London, the nature of the ground in which it stood, and the surrounding wild country, all now covered and its features obliterated by many square miles of bricks and mortar. Mr. Green shows how it was that what was destined to be the greatest city in the world came to be planted where it is, and how its future progress was determined by the physical conditions of its site.

"The commercial greatness of London has made men forget its military importance, but from the first moment of its history till late into the middle ages London was one of the strongest of our fortresses. Its site, indeed, must have been dictated, like that of most early cities, by the advantages which it presented as well for defence as for trade. It stood at the one point by which either

merchant or invader could penetrate from the estuary into the valley of the Thames; and in its earlier days, before the great changes wrought by the embankment of the Romans, this was also the first point at which any rising ground for the site of such a town presented itself on either shore of the river. Nowhere has the hand of man moulded ground into shapes more strangely contrasted with its natural form than on the site of London. Even as late as the time of Cæsar the soil which a large part of it covers can have been little but a vast morass. Below Fulham the river stretched at high tide over the ground that lies on either side of its present channel from the rises of Kensington and Hyde Park to the opposite shores of Peckham and Camberwell. All Pimlico and Westminster to the north, to the south all Battersea and Lambeth, all Newington and Kennington, all Bermondsey and Rotherithe, formed a vast lagoon, broken only by little rises which became the "eyes" and "hithes," the "islands" and "landing-rises," of later settlements. Yet lower down to the eastward the swamp widened as the Lea poured its waters into the Thames in an estuary of its own, an estuary which ran far to the north over as wide an expanse of marsh and fen, while at its mouth it stretched its tidal waters over the mud flats which have been turned by embankment into the Isle of Dogs. Near the point where the two rivers meet, a traveller who was mounting the Thames from the sea saw the first dry land to which his bark could steer. The spot was in fact the extremity of a low line of rising ground which was thrown out from the heights of Hampstead that border the river valley to the north, and which passed over the sites of our Hyde Park and Holborn to thrust itself on the east into the great morass. This eastern portion of it, however, was severed from the rest of the rise by the deep gorge of a stream that fell from the northern hills, the stream of the Fleet, whose waters, long since lost in London sewers, ran in earlier days between steep banks—banks that still leave their impress in the local levels, and in local names like Snow Hill—to the Thames at Blackfriars. The rise or 'dun' that stretched from this tidal channel of the Fleet to the spot now marked by the Tower, and which was destined to become the site of London, rose at its highest some fifty feet above the level of the tide, and was broken into two parts by a ravine through which ran the stream which has since been known as the Wallbrook. Such a position was admirably adapted for defence; it was indeed almost impregnable. Sheltered to east and south by the Lagoons of the Lea and the Thames, guarded to westward by the deep cleft of the Fleet, it saw stretching along its northern border the broad fen whose name has survived in our modern Moorgate. Nor, as the first point at which merchants could land from the great river, was the spot less adapted for trade. But it was long before the trader found dwelling on its soil. Old as it is, London is far from being one of the oldest of British cities; till the coming of the Romans, indeed, the loneliness of its site seems to have been unbroken by any settlement whatever. The 'dun' was in fact the centre of a vast wilderness. Beyond the marshes to the east lay the forest track of southern Essex. Across the lagoon to the south rose the woodlands of Sydenham and Forest Hill, themselves but advance guards of the fastnesses of the Weald. To the north the heights of Highgate and Hampstead were crowned with forest-masses, through which the boar and the wild ox wandered without fear of man down to the days of the Plantagenets. Even the open country to the west was but a waste. It seems to have formed the border-land between two British tribes who dwelt in Hertford and in Essex, and its barren clays were given over to solitude by the usages of primæval war."

Much more that must be of interest to those familiar with modern London does Mr. Green tell us about the early city and its progress, and the influence upon it history, of its site, and the nature of the surrounding country. But these extracts will give the reader a fair idea of the method pursued by Mr. Green in this most interesting volume. The work contains numerous maps showing the condition of the surface in the various regions of the country at the time that the Saxons, Jutes, and Angles were with ruthless vigour laying the foundation of modern England and modern English history. Mr. Green, of course, discusses many incidental questions of interest, among others the extent to which the Celtic element remained after the settlement of the invaders, and influenced their blood and their character. Mr. Green essentially adopts the views advocated by Mr. Freeman, though his Teutonism does not appear to us to be quite so extreme. He brings his history down to about the year 830, when it may be said that England was roughly shaped into those outlines, topographical and social, of which the present conditions are the lineal development.

NOTES

At a recent meeting of the Trustees of the Lewes Studentship in Physiology, which was founded by the late "George Eliot" in memory of her husband, Mr. George Henry Lewes, the vacancy occasioned by the appointment of Dr. Roy to the Brown Professorship of Pathology in the University of London was filled up, according to the terms of the Trust, by the election of Mr. L. C. Wooldridge, D.Sc. (Lond.). Dr. Wooldridge is a former student of Guy's Hospital, who has lately been working in Prof. Ludwig's laboratory at Leipzig. He has already made investigations of importance, one of which, on the part taken by the white corpuscles in the coagulation of the blood, has been read before the Royal Society. The studentship is for three years, and its conditions provide for the holder devoting himself during that time to physiological researches. Wisely administered, such endowments of research are invaluable, and it is to be wished that there were more of them. The first appointment of the Trustees led to the brilliant work of Prof. Roy, and we do not doubt that their present choice will be no less amply justified.

The expedition to be fitted out at the expense of M. Bischoffsheim to observe the solar eclipse next May in Egypt, will include M. Perrotin, director of the Nice Observatory, who will attend specially to the search for intra-Mercurial planets, and M. Thollon, who will have charge of the spectroscopic work. They will be accompanied by M. Guérain, photographer to the Paris Observatory.

The collection of fossil fishes in the British Museum has lately received an immense addition by the transference from Florence Court to the new museum at Cromwell Road of the very extensive and important collection of the Earl of Enniskillen, and when in the course of a few weeks it receives the collection of the late Sir P. G. Egerton, which the Trustees have also purchased, the museum will contain a probably unrivalled collection of fossil fish. The collections of the late Sir P. G. Egerton and of the Earl of Enniskillen were commenced in 1826, when they were fellow-students at Oxford.

The first annual general meeting of the Sanitary Protection Association was held on Saturday in the rooms of the Society of Arts in the Adelphi. Prof. Huxley, having read the report, pointed out that the Society, though it had only been in existence for a short time, had worked successfully. The houses examined had not been the dwellings of poor people, and therefore liable to be found in an insanitary condition, but had been houses occupied by well-to-do people, and of these 6 per cent. were in an absolutely pestiferous condition, leaving it to be the merest chance that they

had not become hotbeds of disease. In addition to this, in two-thirds of the houses inspected there were defects in the drainage arrangements, such as must fill any careful person with alarm, especially where children or delicate persons were among the occupants. Prof. Fleeming Jenkin, one of the consulting engineers of the Association, spoke of the careful manner in which the business arrangements of the Association were conducted, and expressed an opinion that the continued existence of such associations as this must necessarily result in a much more efficient official inspection of dwelling-houses in all parts of the country. Speaking from personal experience of Edinburgh, in which only a similar association exists, Prof. Jenkin said during the recent run of an epidemic of typhoid there had only been one case in any of the houses under the charge of the Association, and in that case the fever was shown to have been contracted by the lady of the house while visiting the sick poor in the vilest districts of the city.

THE discovery of cæsium and rubidium by Bunsen and Kirchhoff was, it is known, one of the first fruits of spectrum analysis. These are the most electro-positive of all known elements, and have a remarkable affinity for oxygen—so great in the case of cæsium, that it has heretofore been found impossible to isolate the metal. The problem, however, has now been solved by Herr Setterberg (*Ann. der Chemie*, Bd. 211, p. 100), by electrolysis of a fused mixture of cyanide of cæsium and cyanide of barium (large quantities of these costly substances having been placed at his disposal). Cæsium is quite like the other alkali metals; it is silver white, and very soft and extensible. Its melting-point is about 26°·5 C.; and its specific gravity 1·88. In the air it ignites spontaneously, and when thrown on water behaves quite like sodium, potassium, and rubidium. Herr Setterberg has anew proved in his experiments that it is quite impossible to obtain cæsium by the method adopted for rubidium and potassium, distilling the carbonate with charcoal at a white heat.

AMONG the institutions for which Jamaica is indebted to the energy and intelligence of the present Governor, Sir Anthony Musgrave, the Institute of Jamaica is probably destined to prove one of the most valuable as a means of diffusing information and organising local effort in the cause of industrial science. The Institute was constituted by a recent law which created a Board styled "The Board of Governors of the Institute of Jamaica," consisting of seven members appointed by the Governor; their duties being to establish and maintain an institution comprising a library, reading-room, and museum; to provide for the reading of papers, delivery of lectures, &c., and holding of examinations on subjects connected with literature, science, and art; to award premiums for the application of scientific and artistic methods to local industries; and to provide for the holding of exhibitions illustrative of the industries of Jamaica. The Institute occupies a building known as Date Tree Hall, in Kingston. On the lower floor there is a small museum containing a good geological collection made by the members of the late Geological Survey, a very complete conchological collection, and another of the birds of Jamaica. A beginning has also been made to form a collection of the fish of Jamaica, and about 150 duplicate specimens have been sent to the Smithsonian Institution to be named by Prof. Baird. On the upper floor is a library which contains a valuable collection of old local prints and records, as well as some 2000 volumes of standard European and American literary and scientific works. The Jamaica Institute in its present form is intended to occupy the position and take up the work of the late Royal Society of Arts and Agriculture, and it receives an annual vote from the Local Government. The present chairman of the Institute is the Hon. Ed. Newton, Lieut.-Governor and Colonial Secretary. Although under its new organisation it has only been in existence about three years, it appears to have already made a good start. Branch associations have been established at Spanish Town, Falmouth, and Sav-la-Mar. Prizes have been offered and awarded for several local industries, and an annual Flower and Horticultural Show has been started with the view of encouraging the cultivation of flowers, fruits, and vegetables. The Governors have recently published in a combined form six lectures delivered under their auspices last year in the Town Hall, Kingston, on local industries. They consist of "Objects of the Jamaica Institute," by the chairman, the Rev. John Radcliff; "Root-Food Growth in Jamaica," by the Rev. Josias Cork, Rector of St. Anne's; "Some Objects of Productive Industry," Part I. Coffee; Part II. Cinchona, by D. Morris, M.A., F.G.S., Director of Public Gardens and Plantations; "The Timbers of Jamaica," by W. Bancroft Espent, F.L.S.; "Stock and Stock-raising," by Archibald Roxburgh; and "The Mineral Springs of Jamaica," by Dr. J. Cecil Phillips. These lectures are of an essentially practical character, and their publication in a handy and compact form must tend to develop the numerous resources of the island.

WE have received a prospectus of the *Journal of the Royal Agricultural and Commercial Society of British Guiana*, edited by Mr. Everard F. im Thurn, M.A., Oxford, and Curator of the British Guiana Museum. This journal, which is to be published half-yearly, on the 30th of June and the 31st of December, is intended to contain not only or chiefly a record of the procedings of the Society of which it is to be the organ, but also papers and occasional notes on agricultural, commercial, geographical, meteorological, chemical, botanical ornithological, entomological, anthropological, and literary subjects connected with British Guiana. A meteorological record will, as soon as it can be organised, form a regular feature in the journal. Lists of the known flora and fauna of the country will be given from time to time, as they can be prepared. A series of vocabularies of the Indian languages of Guiana is also in preparation. Folk-lore, collected from the Negroes and Indians, will occasionally be given, and many other kindred subjects will be treated. The importance of such a journal must be evident, and we hope Mr. im Thurn will receive adequate encouragement.

UNDER the title of "The Natural History of Leeds, Wharfedale, and Nidderdale," it is the intention of the Council of the Leeds Naturalists' Club and Scientific Association to publish during the forthcoming summer a summary of what is at present known of the animals inhabiting the districts marked out for special investigation by the Club. The Club has now been in existence for twelve years, during which time its members have —with more or less assiduity—collected and studied the local fauna, the result being the accumulation of a considerable mass of information, and the time has now arrived at which—if further progress is to be achieved—an epitome of what is already known should be published. The chief hindrance to progress now felt is the acknowledged want of an account of the work already accomplished, as a starting point for fresh investigations and new discoveries. Not only will the work comprise lists of the more important and well-investigated groups of animals, but it will include a notice of every group, however meagrely or imperfectly some of the more obscure ones may have been studied.

AT Angleur, close to Liége, an important archæological discovery has been made. At a depth of only 50 to 60 centimetres about twenty antique bronzes, some of remarkably fine workmanship, have been found. Amongst them are two female statuettes, one statuette of a youth, two female heads, three bearded Mercury heads, two tiger's heads, a lion with raised claw, &c. All

the objects are covered with fine green Patina, and are evidently the parts of an ancient fountain, which adorned the hall or garden of the villa of a wealthy Roman. The discovery is all the more interesting, as the existence of Roman antiquities in the neighbourhood of Liége has never been suspected before.

THE sudden and highly unpleasant occurrence of large quantities of sulphuretted hydrogen at Aetolikon (near Missolunghi), to which we referred a short time ago, was repeated on January 6 last. At the same time a slight earthquake was observed, and quantities of pumice-stone were observed floating upon the sea surface. Orders were given by the authorities to investigate the phenomenon scientifically with a view to ascertaining whether a rise of temperature has taken place in the sea-water or soil of the shore. The depth of the sea is also to be measured, to see whether any variations have taken place.

THE Göttingen Royal Society of Sciences offers, in the physical class, a prize of 50 ducats (say 23*l.*) for the best investigation, with accurate experiments, of the chlorides and amides of cyanogen (the present data regarding these compounds being rather uncertain). Papers must be sent in before the end of September, 1884. The same month this year closes the time for treatment of the prize question in the mathematical class, viz. the nature of the unpolarised ray of light.

THE seeds of some valuable new species or varieties of *Cinchona* that have not, it seems, as yet been introduced to the Indian plantations have recently been consigned to Messrs. Christy and Co., of Fenchurch Street. These new forms are very rich in quinine, and are thus referred to in Markham's "Travels in India and Peru":—"I have been assured by Gironda and Martinez that there are three sorts of Calisaya: the 'Calisaya fina' (*Cinchona Calisaya v. vera*, Wedd.), the 'Calisaya morada' (*C. boliviana*, Wedd.), and the 'Calisaya verde' [*Cinchona Calisaya oblongifolia*]. They also told me that the last-named tree was a very large one, with leaves wholly devoid of any red colour on the nerves, and habitually growing very far down the valleys and even in the plains. A tree of this variety supplies 600 or 700 lbs. weight of bark, whereas the *Calisaya fina* yields only 300 to 400 lbs. Gironda declares that in the province of Muneças, Bolivia, he saw one that furnished 1000 lbs. of tabla, that is to say, of the bark, of the trunk, and lower branches." It is said that better results are to be obtained by cultivating the *Calisaya verde* than the *Calisaya fina*, because although the former yields only 6½ to 9 per cent. of pure sulphate of quinine, yet as it yields twice the amount of bark as the *fina* or *Ledgeriana*, the produce of the *Calisaya verde* is equivalent to from 13 to 18 per cent. of quinine. "Moreover, from the fact that the *Calisaya verde* is a more vigorous tree than the delicate *Ledgeriana*, and will grow at a lower elevation, it is obvious that it can be cultivated to a much greater extent, and may be extremely valuable for grafting the *Ledgeriana* upon, more especially since the attempt to graft the *Ledgeriana* upon *C. succirubra* has proved unsuccessful."

A COMMISSION has been appointed in Paris composed of MM. Wurtz, Berthelot, and other influential men of science connected with politics, to establish a superior School of Chemistry and Physics. The course of instruction will occupy three years. It is stated that M. Cochery will devote to this institution the surplus of the International Exhibition of Electricity.

THE number of municipal services in Paris in which telegraphs or telephones are used is so large that the civic authorities have decided to establish a telegraphic examination for their *employés*.

AN interesting series of papers on the volcanoes of Japan has been commenced by Prof. Milne in the *Japan Gazette* of Yokohama. The articles are compiled almost wholly from native records, and while mentioning the particulars of the various eruptions within the historical period, will also refer to the legends and superstitions of the people respecting these phenomena. Prof. Milne mentions as a noticeable fact the association of many of the eruptions with some great calamity or other remarkable event. The mental effects produced by seismic phenomena have frequently been very curious. Thus an emperor orders the people to pray for forgiveness of their sins on account of an eruption; a governor presents a shrine to the deity of the mountain to prevent any further outbreaks; and priests are ordered to pray to a mountain to cease ruining the crops by pouring forth ashes. The writer also thinks that if the history of earthquakes and volcanoes were closely examined in other countries as well as Japan, these phenomena would be found to play an important part in engendering superstition and producing mental aberrations, traces of which may be met with in the forms of worship. The first of these papers, which is on Mount Aso in Kiushiu, one of the most remarkable volcanoes in the world, appeared on December 31. The series promises to be one of the highest scientific interest.

ON February 12 the new Natural History Museum was opened at Berne.

EARTHQUAKES are reported from Chieti and Castelfrentano, in the Abruzzi, where shocks were observed on February 12 a 3 a.m.

ON February 3 a remarkable fall of meteorites occurred in Transylvania. At Klausenburg an intense light suddenly flashed into view at 3.45 p.m. on that day, the sky being perfectly cloudless. The meteor was seen in the north-east part of the sky, and when it disappeared a white cloud was seen in its stead, which spread into a thin streak stretching from west to east. Soon afterwards a loud report was heard. The next day the news arrived that near Mocs, about twenty-five miles to the east of Klausenburg, some meteorites had fallen; one of these weighs 35 kilogrammes, and penetrated 68 centimetres deep into the ground. Two other pieces were found near Olah Gyeres, and five others near Vajda Kamaras. Prof. Koch collected no less than sixty pieces of smaller dimensions near Gyulatelke, Visa, and Bare to the north of Mocs. The direction of the meteor was from north-west to south-east, to judge from the position of the fragments; the latter were scattered over a line of about fifteen miles in length.

DR. SCHLIEMANN will continue his Trojan excavations this month as soon as the weather permits. The firman he has obtained permits him to extend his researches to the whole Troas. He will therefore not confine himself solely to Hissarlik, but will also closely investigate the environs of Balli-Dagh, where ancient Troy was situated, according to Le Chevalier's theory.

AT the instance of the Conseil d'Hygiène for the Department of the Seine, M. Delpech has drawn up an instructive report (*La Nature*) on the dangers arising from bees. The loss and inconvenience incurred by some sugar refineries in Paris through bee-keepers' establishments in the neighbourhood, attracted notice some time ago; at the Lay refinery the depredation is estimated at 25,000 francs a year, and the workmen, nearly naked, are often stung. The children (1200) at a school in the rue de Tanger, have suffered similarly to a large extent. M. Delpech gives information with regard to the bee's sting, notices three classes of injuries caused by it, and cites a number of cases in which it has proved fatal. Stings on the face are the most serious, the nerve-centres being so near. Bees are evidently not to be trifled with. On the triple score of material damage, great inconvenience, and very real danger, M. Delpech condemns bee-keeping in large centres of population.

AN interesting paper by Mr. F. J. Faraday on "Prehistoric Fishing," is published in "Anglers' Evenings" (Manchester). The

author has brought together much curious and useful information on the piscatory, as well as other habits, of our prehistoric ancestors, and with considerable ingenuity applies the method of evolution in tracing the progress and development of "the gentle art."

AT Steeten on the Lahn (near Runkel) interesting discoveries have recently been made in a cave. They consist of seven human prehistoric skeletons and animal remains. The latter must have belonged to the Tertiary period. They were found in such enormous quantities that several generations must be represented. The spot positively teems with remains of the Cave period, so that it is highly desirable that the State should order that more extensive scientific excavations be speedily made.

THE writer of the article on Lieut. Collet's work on the Compass in last week's NATURE, asks us to make the following correction: p. 383, col. 1, line 8 from bottom, delete "only," and in line 7, instead of "whereas it is three times as much in" read "which is about twice as much as in."

THE additions to the Zoological Society's Gardens during the past week include an African Brush-tailed Porcupine (*Atherura africana*) from West Africa, presented by Mr. J. Cheetham; a Black-necked Heron (*Ardea atricollis*) from Cape Colony, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; two Blossom-headed Parrakeets (*Palæornis cyanocephalus*) from India, presented by Mrs. Francis Fox; a Waxwing (*Ampelis garrulus*), European, presented by Mr. W. H. St. Quintin; a Carrion Crow (*Corvus corone*), British, presented by Mr. F. H. Worsley Benison; a Rhesus Monkey (*Macacus erythræus*) from India, a Bonelli's Eagle (*Nisaëtus fasciatus*), European, deposited; two Common Buntings (*Emberiza miliaria*), two Black-headed Gulls (*Larus ridibundus*), a Common Curlew (*Numenius arquata*), a Bar-tailed Godwit (*Limosa lapponica*), two Knots (*Tringa canutus*), British, purchased.

OUR ASTRONOMICAL COLUMN

THE EARLIEST DAY-LIGHT OBSERVATIONS OF STARS.—In No. 2616 of the *Astronomische Nachrichten* Prof. Winnecke has an interesting note on the question, Who first observed stars in full daylight? The credit of the observation has been generally accorded to J. B. Morin in 1635. Arago, for instance, says: "Il est evident que c'est à Morin qu'il faut remonter pour trouver la première observation authentique d'une étoile vue en plein jour;" Zach and many other astronomical writers have held the same opinion. Morin's observations are found in his work, "Longitudinum Terrestrium necnon Cœlestium nova et hactenus optata Scientia," first published, as it appears, in an extended form at Paris in 1638. At the end of March, 1635, he saw Arcturus half an hour after sunrise. This observation of Morin's appears to have been overlooked in France, since in May, 1669, we find Picard expressing his surprise that he had been able to observe the meridian altitude of Regulus thirteen minutes before sunset; his observation is printed in Lemonnier's "Histoire Céleste": "Le 3 mai (1669), hauteur méridienne de Regulus 54° 42′ 50″, cette hauteur méridienne fut prise en *plein jour* à 7h. 5m. du soir, environ 13m. avant le coucher du Soleil, ce qui ne s'étoit encore jamais fait." On July 23 following he observed the meridian-altitude of Arcturus, while the sun was 17° above the horizon, and speaks of the observation as a remarkable one, concluding: "il est maintenant facile de trouver immédiatement les Ascensions droites des Etoiles fixes non seulement par les horlogès à pendule, mais aussi par l'observation du vertical du Soleil au même temps qu'on observera la hauteur méridienne d'une etoile fixe."

Prof. Winnecke points out that Morin was preceded in his discovery that the stars may be observed in daylight by more than one person. In a letter written from Amsterdam to Gassendi, by Martinus Hortensius, and dated October 12, 1636, he mentions that observations such as Morin had claimed to be the first to make, were by no means new to him, and from the dates of the publications in which he records his own observations it is clear that his claim of priority to Morin is justified, though when his earliest observation was made cannot, as Prof. Winnecke remarks, be certainly inferred. Schickard, Professor of Hebrew and Mathematics at Tubingen, whose first work, the "Astroscopium," appeared in 1623, and was frequently reprinted, saw Arcturus in broad daylight as early as 1632. In the "Historia Cœlestis, ex observationibus Tychonis Brahe," by Albertus Curtius, at p. 956 we read: "1632 Martii 2. Nota. Cor Scorpii claro die adhuc à me visum per conspicilia tamen cum Saturnus ægre cognosceretur: nec aër fuit omnino purus."

Prof. Winnecke concludes that Schickard, as well as Hortensius, had observed fixed stars in daylight previous to Morin, who, as we have said, has been generally credited with this advance in astronomical observation.

BINARY STARS.—Mr. J. L. Casey, U.S.A., has calculated first approximations to the orbits of ϕ Ursæ Majoris and Σ 1757 (Piazzi xiii. 127). The former is one of O. Struve's discoveries, his first and last published epochs being—

1842·34, Pos. 4°·4, Dist. 0″·46.
1875·48, ,, 295·5, certainly oblong.

The apparent motion being direct, or with increasing angles, these indicate a change of 290° in thirty-three years.

Σ 1757 was measured by Struve in 1825. For comparison with his first epoch, we add Prof. Asaph Hall's for 1879—

Struve, 1825·37, Pos. 10°·0, Dist. 1″·60
A. Hall, 1879·40, ,, 68·9, ,, 2·34

The elements are as follow:—

	ϕ Ursæ Majoris.		Σ 1757.
Periastron passage	1877·12	...	1797·42
Node	105° 18′	...	344° 43′
Node to periastron	72° 7′	...	315° 28′
Inclination	57°5 7′	...	29° 32′
Excentricity	0·788	...	0·5079
Semi-axis major	0″·54	...	2″·29
Period	115·4 years.	...	401·0 years.

GEOGRAPHICAL NOTES

AT the meeting of the Geographical Society on Monday last, Major J. E. Sandeman, B.S.C., read a paper on recent explorations of the sources of the Irawaddy. He referred first to Mr. R. Gordon's able report on the hydrology and hydrography of the river, in which the old theory of the Saupo, or great river of Tibet, being the main source of its vast stream, is revived, and then to what has lately been done, showing that the Saupo more probably unites with the Kihong. Major Sandeman next dealt with some endeavours to reach the source of the Irawaddy, more especially that made by a Burman named Alaga, who had been trained by himself. This man started from Bhamo in October 1879, and was absent six months. He brought back a good deal of information respecting the western and eastern branches of the Irawady, but we cannot see how he can be said to have explored their sources. It was somewhat unsatisfactory to learn that "political considerations"—the old Indian bugbear—prevented Major Sandeman from stating why the explorer was compelled to turn back before doing what he was sent to do. Though the geographical results of Alaga's journey are not what might have been expected, he has brought back some very interesting information regarding the domestic habits, religious customs, &c., more particularly of the Kachins, or Kakhyens. In concluding his paper Major Sandeman summed up the various attempts which have been made to reach the sources of the Irawaddy, and to discover the true outlet of the Saupo.

COL. VENIUKOF has informed the French Geographical Society that M. Lessar, a Russian engineer officer, has completed the levelling of the country between Askabad and Sarakhs. This operation has proved the practicability of constructing a railway between these two places, and even for some forty miles beyond Sarakhs, in the valley of the Heri-rud (Tejend). It is estimated that the cost would not exceed 320,000*l*. At the same time M. Gladycheff, the astronomer of the expedition, has determined the geographical position of thirteen points between Askabad, Sarakhs, and Meshed. At Meshed he is said to have purchased the plan of the town which Mr. E. O'Donovan had made, but apparently lost. Perhaps Mr. O'Donovan may enlighten us on this point, when he gives his account of his varied

experiences in the Merv region at the Geographical Society's meeting on March 27.

Dr. A. E. Regel, well-known through his travels, undertook a new journey to Central Asiatic districts which have never been visited by a European before, and has now returned richly laden with scientific treasures. He began his work with an investigation of the Matchi Valley near the Zarawshan glaciers, crossed the mountain passes of Pakchif and Sagridetch, and reached the towns of Kala and Chumba, which stand upon the high plateau of the Amu Daria. Concerning this part he made interesting ethnographical observations. The type of the population of these districts is a mixed one; in Darwas the type of Aryans has remained pure, yet the hair is not always black, lighter shades being frequently met with; sometimes the head is completely shaved. The women do not cover their faces and marry according to their choice; their faces are almost European in appearance, sometimes gipsy like. The language at Darwas varies but little from that spoken at Bokhara and Samarkand. Quite another language is found at Shugnan, which sounds almost like a European language, as do also the national songs of these people.

A Russian staff-officer, who is said to have followed Col. C. E. Stewart's example by disguising himself as a merchant, and appears to have been recently travelling about in Khorassan, has published in the *Nouveau Temps* some interesting papers on the country and its Kurdish inhabitants.

Captain von Wohlgemuth, of the Austrian Navy, has been appointed leader of the Austrian Polar expedition to establish an observing station at Jan Mayen. The steamer, which will leave Pola early in April next, is now being fitted out most energetically.

The Geographical Society of the Pacific, founded at San Francisco last summer, have just issued the first number of their *Proceedings*, which is entirely occupied by a paper prepared for the Society by Capt. Hooper, on the recent cruise of the *Corwin* in the Arctic Sea. In addition to the account of his visit to Wrangel Land, &c., Capt. Hooper gives some details as to the manners and customs of the Chukches. Capt. Hooper proposes to deal with the very important subject of currents in another paper, but he makes a few remarks on the influence of the Kurosiwo or Japanese warm stream on the waters of Behring Strait, &c.; and he also furnishes a table showing his determination of the magnetic declination and dip in the Arctic regions, from the end of May to the beginning of October, 1881.

The new number of the American Geographical Society's *Bulletin* contains an account by Commander H. H. Gorringe U.S.N., on a cruise along the northern coast of Africa, and a paper by Mr. Jas. Douglas, jun., on the Geography, People, and Institutions of Chile.

ON THE SENSE OF COLOUR AMONG SOME OF THE LOWER ANIMALS[1]

As I have already mentioned in a previous communication (*Journ.* Linn. Soc. vol. xv. p. 376 (Part No. 87), M. Paul Bert (*Archiv. de Physiol.* 1869, p. 547) has made some very interesting experiments on a small freshwater crustacean belonging to the genus *Daphnia*, from which he concludes that they perceive all the colours known to us, being, however, especially sensitive to the yellow and green; and that their limits of vision are the same as ours.

Nay, he even goes further than this, and feels justified in concluding, from the experience of two species—Man and *Daphnia*—that the limits of vision would be the same in all cases.

His words are:—

A. "Tous les animaux voient les rayons spectraux que nous voyons."

B. "Ils ne voient aucun de ceux que nous ne voyons pas."

C. "Dans l'étendue de la région visible, les différences entre les pouvoirs éclairants des différents rayons colorés sont les mêmes pour eux et pour nous."

He also adds that, "puisque les limites de visibilité semblent être les mêmes pour les animaux et pour nous, ne trouvons-nous pas là une raison de plus pour supposer que le rôle des milieux de l'œil est tout-à-fait secondaire, et que la visibilité tient à l'impressionnabilité de l'appareil nerveux lui-même."

[1] Paper read at the Linnean Society on November 17, 1881, by Sir John Lubbock, Bart., M.P., F.R.S., President.

These generalisations would seem to rest on a very narrow foundation. I have already attempted to show that the conclusion does not appear to hold good in the case of ants, and I determined therefore to make some experiments myself on Daphnias, the results of which are embodied in the present communication.

Prof. Dewar was kind enough again to arrange for me a spectrum, which, by means of a mirror, was thrown on to the floor. I then placed some Daphnias in a wooden trough 14 inches by 4 inches, and divided by cross partitions of glass into divisions, so that I could isolate the parts illuminated by the different-coloured rays. The two ends of the trough extended somewhat beyond the visible spectrum. I then placed fifty specimens of *Daphnia pulex* in the trough, removing the glass partitions so that they could circulate freely from one end of the trough to the other. Then, after scattering them equally through the water, I exposed them to the light for ten minutes, after which I inserted the glass partitions, and then counted the Daphnias in each division. The results were as follows:—

Number of Daphnias

	Beyond the blue.	In the red and yellow.	In the greenish yellow and green.	In the blue.	In the violet.	Beyond the violet.
Obs. 1. ...	0	20	28	2	0	0
„ 2. ...	1	21	25	3	0	0
„ 3. ...	2	21	24	3	0	0
„ 4. ...	1	19	29	1	0	0
„ 5. ...	0	20	27	3	0	0
	4	101	133	12	0	0

I may add that the blue and violet divisions were naturally longer than the red and green.

May 25.—Tried again the same arrangement, but separating the yellow, and giving the Daphnias the choice between red, yellow, green, blue, violet and dark:—

	Dark.	Violet.	Blue.	Green.	Yellow.	Red.
Exp. 1. ...	0	0	3	39	5	3
„ 2. ...	0	1	2	37	7	3
„ 3. ...	0	0	4	31	10	5
„ 4. ...	0	1	5	30	8	6
„ 5. ...	0	1	4	33	6	6
	0	3	18	170	36	23

Of course it must be remembered that the yellow band is much narrower than the green. I reckoned as yellow a width of ¾ inch, and that of the green 2 inches.

Again,

	Dark.	Violet.	Blue.	Green.	Yellow.	Red.
Exp. 1. ...	0	0	4	30	6	10
„ 2. ...	0	1	3	25	8	13
„ 3. ...	0	0	2	24	9	15
„ 4. ...	1	0	3	25	8	13
„ 5. ...	0	1	2	24	7	16
	1	2	14	128	38	67

M. Paul Bert observes (*l. c.*) that in his experiments the Daphnias followed exactly the brilliancy of the light. It will be observed, however, that in my experiments this was not the case; as there were more Daphnias in proportion, as well as absolutely, in the green, although the yellow is the brightest portion of the spectrum.

May 18.—The same arrangement as before. In order to test the limits of vision at the red end of the spectrum, I used the trough so that the extreme division was in the ultra-red and the second in the red. I then placed 60 Daphnias in the ultra-red. After five minutes' exposure I counted them. There were in the

	Red.	Ultra-red.
Exp. 1.	54	5
„ 2.	56	4
	110	9

I now gave them four divisions—dark, red, ultra-red, and dark again. The numbers were:—

	Dark.	Red.	Ultra-red.	Dark.
Exp. 1.	5	47	6	2
„ 2.	9	41	7	3
	14	88	13	5

It seems clear, therefore, that the ultra-red is to them practically the same as darkness.

I then so arranged the trough that the yellow fell in the middle of one of the divisions. The result was:—

Number of Daphnias

	Ultra-red and lower red.	Upper edge of red, yellow, and lower green.	Greenish blue and blue.	Violet.	Ultra-violet.
Exp. 1. ...	8	38	4	0	0
,, 2. ...	9	36	5	0	0
,, 3. ...	8	39	3	0	0
	25	113	12	0	0

I then shut them off from all the colours excepting red, giving them only the option between red and ultra-red:—

	Red.	Ultra-red.
Exp. 1.	46	4
,, 2.	47	3
,, 3.	44	6
	137	13

I then left them access to a division on the other side of the red, which, however, I darkened by interposing a piece of wood. This enabled me better to compare the ultra-red rays with a really dark space:—

	Dark.	Red.	Ultra-red.
Exp. 1.	4	43	3
,, 2.	3	45	2
	7	88	5

Certainly, therefore, their limits of vision at the red end of the spectrum seem approximately to coincide with ours.

I then proceeded to examine their behaviour with reference to the other end of the spectrum.

Ultra-violet.	Dark.
58	2
286	14

Not satisfied with this I tried to test it in another way.

I then shut them off from all the rays except the blue, violet, and ultra-violet. The result was as follows:—

Number of Daphnias

	Ultra-violet.	Violet.	Blue.	Dark.
Exp. 1.	1	9	38	2
,, 2.	4	6	38	2
,, 3.	0	2	46	2
	5	17	122	6

I then gave them only the option of ultra-violet, violet, and darkness:—

	Ultra-violet.	Violet.	Dark.
Exp. 1.	8	48	4
,, 2.	6	48	6
,, 3.	12	47	1
,, 4.	15	42	3
,, 5.	4	53	3
	45	238	17

I then tried ultra-violet and dark. The width of the violet was 2 inches; and I divided the ultra-violet portion again into divisions each of 2 inches, which we may call ultra-violet, further ultra-violet, and still further ultra-violet. The results were:—

Number of Daphnias

	Still further ultra-violet.	Further ultra-violet.	Ultra-violet.	Dark.
Exp. 1.	0	6	52	2
,, 2.	0	5	52	3
,, 3.	0	6	50	4
,, 4.	0	4	53	3
,, 5.	0	4	54	2
	0	25	261	14

May 18.—I then again tried them with the ultra-violet rays, using three divisions, namely, further ultra-violet, ultra-violet, and dark. The numbers were as follows, viz. under the

	Further ultra-violet.	Ultra-violet.	Dark.
Exp. 1.	6	50	4
,, 2.	3	55	2
	9	105	6

To my eye there was no perceptible difference between the further ultra-violet and the ultra-violet portion; but slightly undiffused light reached the two extreme divisions. It may be asked why the still further ultra-violet division should have been entirely deserted, while in each case two or three Daphnias were in the darkened one. This, I doubt not, was due to the fact that the darkened division being next to the ultra-violet, one or two in each case straggled into it.

I then placed over the ultra-violet division a glass cell containing a layer of sulphate of quinine about ⅜ inch in depth, and over the further ultra violet a similar cell with water. I had expected that the great majority would have collected under the water-cell. The numbers, however, were:—

	Further ultra-violet with cell containing water.	Ultra-violet with cell containing sulphate of quinine.
Exp. 1.	8	50
,, 2.	4	54
,, 3.	11	49
,, 4.	4	56
	27	209

The reason of this, however, seemed evident as soon as I tried the experiment; because though the sulphate of quinine stops the ultra-violet rays, it turns them into blue light, and, to our eyes at least, actually increases the brilliance.

I then took a cell in which I placed a layer of 5 per cent. solution of chromate of potash less than an eighth of an inch in depth, which, though almost colourless to our eyes, completely cut off the ultra-violet rays. I then turned my trough at right angles, so that I could cover one side of the ultra-violet portion of the spectrum with the chromate and leave the other exposed. The numbers were as follows:—

	Side of the ultra-violet covered with chromate of potash.	Side uncovered.	Dark.
Exp. 1.	5	55	0
I now covered up the other side.			
,, 2.	3	57	0
Again covered up the same side as at first.			
,, 3.	4	56	0
Again covered up the other side.			
,, 4.	3	57	0

May 19.—Again the same arrangement. I reduced the chromate of potash to a mere film, which, however, still cut off the ultra-violet rays. I then placed it, as before, over one-half of the ultra-violet portion of the spectrum, and over the other half I placed a similar cell containing water. Between each experiment I reversed the position of the two cells. The numbers were:—

	Under the film of chromate of potash.	Under the water.
Exp. 1.	8	52
,, 2.	4	56
,, 3.	10	50
,, 4.	7	53
	29	211

Evidently even a film of chromate of potash exercises a very considerable influence; and indeed I doubt not that if a longer time had been allowed, the difference would have been even greater.

It seems clear, therefore, that a film of a 5 per cent. solution of chromate of potash only ⅛ inch in thickness, which cuts off the ultra-violet rays, though absolutely transparent to our eyes, is by no means so to the Daphnias.

I then again returned to the sulphate of quinine; but instead of placing it close to the water, I suspended it at a height of 3

feet, so that the Daphnias were far less directly illuminated by the scattered light.

As in the preceding case, I placed by the side of it a similar cell containing water, and suspended them side by side over the water containing the Daphnias, and reversing the position after each experiment. The numbers were as follows:—

	Under the sulphate of quinine.	Under the water.
Exp. 1.	13	47
,, 2.	17	43
,, 3.	12	48
,, 4.	11	49
,, 5.	20	40
,, 6.	18	42
,, 7.	20	40
,, 8.	15	45
	126	354

Although the contrast in this latter series is not so great, still it is unmistakable. It seems to me, therefore, though I differ with great reluctance from so eminent an authority as M. Paul Bert, that the limits of vision of Daphnias do not, at the violet end of the spectrum, coincide with ours, but that the Daphnia, like the ant, is affected by the ultra-violet rays.

GLACIERS AND GLACIAL PERIODS IN THEIR RELATIONS TO CLIMATE[1]

NOW that the *effects* of glacial action, present and past, have been so well studied, the question as to *causes* deserves to be more attentively considered, and it seems that meteorologists must now take it in hand, having too long neglected it. A cursory glance on the present conditions of our globe shows us that cold alone will not produce permanent snow and glaciers when vapour of water is deficient. There are no permanent snow nor glaciers in the Verkhojansk Mountains in North-East Siberia, yet at the foot of them the mean annual temperature is below 4° F., and that of January below −56° F. The reason is that the snowfall is but small, and thus the snow is easily melted in summer. In New Zealand, on the contrary, owing to the enormous snowfall in the mountains, glaciers descend to about 700 feet above sea-level on the west side (lat. 43° S.). At this height the mean annual temperature must be about 50° F., and snowfall and frost are of rare occurrence, even in winter.

The great importance of an abundant supply of vapour admitted, and thus the necessity of surfaces covered by sea, what temperature of the surface of the seas is the most favourable to the production of glaciers? This depends certainly on the height above sea-level where the *nevé* is formed; but so far as we consider lowlands and moderate heights, say below 6000 feet, the surface temperature of the water should not very much exceed the freezing point, otherwise the vapour evaporated from the sea and condensed on the surrounding lands will be rain, and not snow, thus contributing rather to melt the existing snow and not to form new snow-layers. For lowlands and very small elevations a temperature of the surrounding seas of about 32° F. is that which is most favourable to the formation of snow, and if the last is falling in sufficient quantities to form permanent snow and glaciers.

The deeper and opener the seas are, the better, for such seas do not freeze entirely, as the winds and tides always break the ice which is already formed; thus seas of that kind have, even in the midst of winter, a considerable open surface, which evaporates freely. Shallow seas surrounded by land can be entirely frozen in winter, and thus the ice and snow which cover them, considerably cooled by radiation and cold winds from the land, evaporate but very little, and are by far less favourable to a great precipitation of snow and ice. Thus the cold of winter in mediterranean seas is a condition very unfavourable to a great evaporation from their surface in the cold season, and to a heavy snowfall on the surrounding land. With the premises given above it will be easy to understand the difference in the extent of ice-sheets and glaciers, or their total absence in the different regions of our globe at the present time, as well as the probable causes of former glaciation.

Abstracting for once from the polar regions of the southern hemisphere, of which we know but little, we see that in the higher latitudes of the southern hemisphere (40°–67°) the extent of seas is much greater than in the same latitudes of the northern hemisphere. We know, further, that the seas of these latitudes receive considerable quantities of warm water from tropical seas. Now the south tropical seas do not exceed so much in extent the north tropical seas, then the seas between 40°–67° S. exceed the seas between 40°–67° N. If the latter were even to receive the same relative proportion of warm water from the tropical seas of their own hemisphere than the southern seas of the same parallels, the thermal effect would be yet greater, on account of the limited extent of the seas between 40°–67° N. But the greater extension of the south-east trades and their existence even to the north of the equator pours a great quantity of the warm water of the southern tropical seas into the seas of the north temperate zone, thus giving probably an equal if not a superior quantity of warm water to seas of not half the extent. How much this must tend to raise the temperature of the seas between 40°–67° N. is easy to see. This explains why there is so little permanent snow in these northern latitudes in the proximity of the sea, notwithstanding the great precipitation existing there, and the greatest quantity of it falling in the colder part of the year. The temperature of the sea-surface is so high, that much more rain than snow falls even in winter. Let us take an example. The sea-surface between the south-west of England and the south of Ireland has a temperature of above 50° F. even in January. Supposing a saturated stratum of air to rise from these seas, it would have cooled down to about 38·4° F. at an elevation of 4000 feet, that is at the level of the highest peaks of the British Islands.[1] The resulting precipitation will be rain and not snow. Thus a broad and swift atmospherical current from the south-west will give rain and not snow, even in the mountains of England and Scotland. As the south-west are the prevailing winds the absence of anything like permanent snow is easily understood. In Norway, where the surrounding seas are colder and the elevations greater, permanent snow and glaciers do exist. Greenland, which is surrounded by much colder seas, yet never entirely frozen, has an ice-sheet covering all the interior and forcing glaciers to the sea. The height of the ice-sheet is so great, and the sea so cold, that probably even in summer the precipitation is always snow in the interior. As the seas near Greenland are not warmer than 41° F. in summer, a saturated stratum of air rising from them will have a temperature of about 31·1° F. at a height of 3000 feet, that is, much below the level of the ice-sheet in the interior.

The seas between 40–67° S. have generally a much lower temperature than the northern seas of the same latitude (see, for example, the map in Wild's "Thalassa.") Thus their conditions are much more favourable to the production of snow at small elevations above the sea-level, and owing to the small difference of the temperature of winter and summer in so strictly oceanic climates, snow will fall even in summer. This explains why we find so great sheets of ice and glaciers descending to sea-level in all lands and islands south of 50° S. (the eastern part of South America, the Falkland and Auckland Islands excepted).

As there is either a continent or a great cluster of high islands in high southern latitudes, and as the seas north of it give great quantities of moisture to be condensed to snow, a glaciation exceeding all that is known in the north hemisphere is the result, and the glaciers, descending to the sea, and their broken ends floating to the ocean as icebergs, they in their turn cool the sea water, and thus bring about temperatures favourable to the formation of snow. Thus cause and effect react on each other, as is so often the case. We know besides that the southern seas do not freeze to a great extent, so that ice-fields, so frequent in higher northern latitudes, are far less common in the south, the icebergs being the prevailing form of ice there. This shows us that there is, on the southern seas, always a great extent of open water, and thus an active evaporation.

In the northern hemisphere, on the contrary, the colder seas are mostly shallow and surrounded by land, and thus frozen over to a great extent in winter (for example, the White and Kara Seas, the Sea of Okhotsk, Hudson's Bay, the bays and straits between the archipelago of North America). Thus the evaporation is checked just at the time most favourable to a heavy snowfall.

The continents of the northern hemisphere are too extensive, too little open to the influences of the sea and its moisture, to have extensive ice-sheets. The example of mountains in North-East Siberia shows this very well. Similarly the great interior

[1] Short analysis of my paper under the same title, published by the *Zeitschrift der Gesellschaft für Erdkunde* in 1881.

[1] On the Thermal Conditions of Rising and Descending Strata of Air. See Guldberg and Mohn's "Études sur les Mouvements de l'Atmosphère."

plateaux in the centre of Asia, north of the Karakoram and east of the Pamir, are too dry for glaciers, notwithstanding the height of the mountains rising over them. The continental parts of Eastern Asia (that is China, Mandchooria, the Amoor provinces, &c.) have more moisture, but it falls nearly entirely in summer, and, owing to the high temperature of the continent at this season, rain, and not snow, prevails to the height of 12,000 or even 15,000 feet. The winter is the time of the north-west monsoon, which brings cold but dry weather, with a cloudless sky. The monsoon climate of these regions, that is the prevalence of cold, dry winds in winter and moist winds in summer, being the result of the geographical conditions, it must have prevailed since the great features of the centre and east of Asia were as they are. The existence of the plateaux and elevations to the south and west of them is especially important. As all geologists are agreed that at least since the Pliocene period this has been the case, I must conclude that the monsoon climate existed in Eastern Asia the whole time, and thus conditions exceedingly unfavourable to an accumulation of permanent snow and glaciers. It is well known that Pumpelly and Baron Richthofen did not find any traces of former glacier action in China or on its western and northern borders; neither did Dr. Schmidt find any in the Amoor provinces. Thus geological and climatological evidence are perfectly agreed, the first showing that there were no glaciers, and the second why there were none. As to the plateaux of Central Asia, they must have been exceedingly dry since the rise of the Himalaya and Karakoram to the south and the Pamir heights to the west of them, and thus have had nothing corresponding to the later glacial periods of Europe and North America. The geological evidence, especially the studies of Stoliczka, confirms this.

As to the former glaciation of Europe and North America, the conditions which must have led to it are, in general, greater cold in regions which have now an oceanic climate with heavy precipitation, and a more oceanic climate in regions which are cold enough, but where the rain and snow are now too deficient, especially in the cold season. Great Britain belongs certainly to the former class, that is, there is moisture enough, but, owing to the warm seas surrounding the islands, the temperature is too warm for glaciers. Thus a diminution of the quantity of warm water brought from the tropical Atlantic, or a change of these currents so as to stop their influence on Great Britain altogether, are the principal conditions needful to bring about a heavy snowfall, first in the mountains, and then even on more moderate heights, and to render the snow persistent. A change of the same kind would increase the present glaciers of Norway, enabling them to reach the sea even south of the 60° N., and give rise to new glaciers.

It is now pretty certain that all Scandinavia, Finland, North-West Russia, and Northern Germany were covered by a sheet of ice which gradually filled the Baltic and North Seas and reached west of Great Britain, to where the depth of the Atlantic is now about 600 feet. Many geologists would have the whole extent of country standing much higher to initiate such an intense glaciation. I would not object to this for the mountainous districts, those of Scandinavia especially; but there is decidedly no proof of it for the plains, and the arguments from a climatological point are strongly against such a supposition. A rise of less than 600 feet in North-West Europe would empty the Baltic and North Seas, and extend the Continent to much beyond Ireland. This would give to Königsberg in Prussia a climate as continental as that of Orenburg on the borders of the Kirghiz steppes.. Such a dry climate would be so unfavourable to permanent snow and glaciers, that no amount of rise of the land would outweigh it.

I suppose, on the contrary, that a rise of the seas or a sinking of the land had very much increased the extent of country covered by the sea, and besides giving access to the cold water and ice of the Arctic Ocean through what now are the Lakes of Ladoga, Onega, and the White Sea, brought a moist and cold climate to the whole region. Thus an accumulation of snow and ice was brought about first on the highlands, and the ice by and by expelled the waters of the shallow seas (the present lowlands of North-West Russia, Scandinavia, and North Germany) and then of the somewhat deeper seas (the present Baltic and North Seas). As the ice advanced, the elevation of its interior part and the cooling due to the presence of snow and ice counterbalanced the greater distance of the sea, favouring a heavy snowfall even in summer, *i.e.* giving the conditions which now exist in the interior of Greenland.

Similarly in North America the submersion of a part of the Western plains, uniting Hudson's Bay to the Gulf of Mexico, was necessary to the beginning of intense glaciation. A vast extent of cold sea was thus called into existence in the West, and as the westerly winds are very prevalent and strong there, this must have caused a heavy snowfall during the greater part of the year. It is known that even now the precipitation of rain and snow is very heavy in the United States and part of Canada from the Atlantic to the Mississippi, so heavy that it it is unequalled by any extensive region of the globe under the same latitudes. Besides, the cold sea to the West went far to prevent the influence of the hot and dry summer temperature on the plains between the Rocky Mountains and the 100° W. or even beyond. American geologists have shown how closely the ice-sheet conformed to the present amount of precipitation, there being a "driftless" region in Wisconsin, which is now drier than the surrounding country, having less than thirty-two inches of precipitation in the year, and of four in winter.[1] The same relation is to be found in the Old World wherever the phenomena are better studied; glaciation was more extended in the moister Western Alps than in the drier Eastern Alps; it was less in the Caucasus and Central Asia (*i.e.* the part west of the Pamir and Thian-Shan) than in the Alps, &c.

I have now to consider the possibility of so-called ice-caps reaching in an unbroken sheet from the Pole to a latitude of 45°–50°. All I mentioned before leads to the conclusion that they are impossible, as on extensive and deep seas an accumulation of ice is impossible, as the ice is immediately broken by winds, currents, and tides, and on great continents the climate is too dry. Thus now there is nothing like an extension of ice of that kind in the southern hemisphere, because the greatest part of the latitudes above 45° are open ocean, and on the northern because the continents are too dry. And the one or the other cause always must have prevented an extension of ice of a magnitude as stated above, and mostly probably there were both too extensive continents and too great and deep oceans to allow of an accumulation of ice on a very great part of them at the same time. Thus a displacement of the centre of gravity due to ice of the magnitude supposed by Mr. Croll on this hypothesis, is inadmissible. But one thing is worthy of remark in this hypothesis: it is the search for a cause which may explain the changes of the level of the sea, which certainly have taken place on the globe, and which are now explained as due to the rise or subsidence of the land on the Lyellian hypothesis of the stability of the sea-level.

The influence of a high eccentricity on the accumulation of snow and glaciers has next to be considered. This is a question which has been considered especially by British geologists, and the majority of them agree in attributing a great influence to that cause, and in thinking that with the winter in aphelion during a high eccentricity there existed conditions favourable to an accumulation of ice.

Let us take the simplest conditions, those in the interior of a great continent, for example, Asia. We should expect then, during high eccentricity, a greater cold in mid-winter, and greater heat in midsummer when winter is in aphelion. A greater cold in winter would not be conducive to an accumulation of snow, while a more intense heat in midsummer would probably melt the snow at heights where at present temperature does not rise much above 32° F. In the monsoon regions a colder winter in the interior, with the accompanying higher pressure of the air, would intensify the cold and dry winter monsoon winds, and thus bring about conditions even less favourable to an accumulation of snow. Greater heat in summer in the interior of Asia would intensify also the moist summer monsoon, and thus give a greater amount of precipitation. But owing to the small amount of snow falling in winter and its rapid melting, the temperature would rise over 32° F., even at considerable heights, greater than now, and the precipitation due to the moist winds would be rain. Thus, in the interior and eastern part of a continent like Asia, winter in aphelion during a high eccentricity would be less favourable than even the present conditions to permanent snow and glaciers.

As to the western parts of continents and to islands, they are more fully under the influence of the seas. As there is no reason to suppose that the surface-temperature of the sea would be lower during winter in aphelion and high eccentricity, it follows that there will not be more snow than now in countries where rain is the rule, even in winter, all other things equal. As

[1] A. Dana in *Sill. Journ.* c. xv. p. 250.

there is also nothing in these astronomical changes to intensify the moist (principally westerly) winds in winter, there will also not be a greater quantity of snow falling at that season in regions having a regular covering of snow in winter. The greater heat and rarefaction of the air in the interior of continents in summer will cause the air of the oceans to flow thither with greater force, and such a movement of the air is favourable to more abundant summer rains than are experienced now, and thus to a melting of the snow in mountainous countries.

Thus it would seem that winter in aphelion during high eccentricity would have rather the opposite effect to that which is generally attributed to it, but it seems to me that the effect would be in any case but slight, and not by far to be compared to that of the distribution of land and sea, mountains and lowlands; in other words, to that of the geographical conditions. With the change of these the extent and distribution of snow and ice must change also.

An attentive study of the physical geography of the earth and of its influence on climates, together with a judicious application of the simplest physical theories, will enable us to gain by and by a better knowledge of geological climates. The problem is an arduous one, but now that the studies are directed in the right way, there is no doubt of the final success.

A. WOEIKOF

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

AT a recent meeting of the trustees of the Mason College in Birmingham, the executors of Sir Josiah Mason presented a statement showing the amount to which the college will be entitled under the will of Sir Josiah Mason. After paying claims on the estate and providing for legacy duty, about 20,000*l.* will accrue to the college within the next three years, and after certain life interests are satisfied, a further sum of about 15,000*l.* will be available, making a total of 35,000*l.* for the estate. The benefactions of Sir Josiah Mason to the college building, endowment, and legacies will then amount to a total of 210,000*l.* The building and endowment of the orphanage and almshouses represent a sum of about 260,000*l.*

IN our University Intelligence last week, in the paragraph relating to Prof. MacAlister's lectures, the word *chemical* should have been *clinical*.

SCIENTIFIC SERIALS

The American Naturalist, December, 1881, contains—F. M. Endlich, on Demerara.—C. E. Bessey, a sketch on the progress of botany in the United States in 1880.—J. D. Caton, the effects of reversion to the wild state in our domestic animals.—W. R. Higley, on the microscopic and general characters of the peach tree affected with the "yellows" (concluded).—W. H. Dall, on intelligence in a snail.

January, 1882.—S. A. Forbes, on the blind cave-fishes and their allies (a new species of Chologaster, *C. papilliferus*, from a spring in Southern Illinois, is described).—Dr. C. F. Gissler, on a singular parasitic Isopod (*Bopyrus palæmoneticola*, Packd.), and on some of its developmental stages (this interesting species, which is figured, was found on about 10 per cent. of the common prawns (*Palæmonetes vulgaris*) examined.—William Trelease, on the heterogony of *Oxalis violacea*.—J. M. Anders, Forests, their influence upon climate and rainfall.—A. S. Packard, jun., glacial marks in Labrador (with a plate).

THE last number of the *Journal of the Russian Chemical and Physical Society* (vol. xiv. fasc. 1) contains, besides the minutes of proceedings, papers on the constitution of compounds of the indigo group, by M. Lubavin; an interesting paper on the influence of molecular weight of homologues in the so-called incomplete reactions, by Prof. Menshutkin; on Caucasus naphtha, by MM. Markovnikoff and Ogloblin; on the distribution of magnetical currents, by M. Sloughinoff; and on the electromagnetic theory of light of Wm. Maxwell, by M. Borgman.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 26.—"An attempt at a Complete Osteology of *Hypsilophodon Foxii*," by J. W. Hulke, F.R.S. Abstract.

After a reference to papers descriptive of parts of the skeleton of this dinosaur, by Professors Owen, Huxley, and himself, the author gives a detailed description of the skull, vertebral column, shoulder, and hip-girdles, with their appendages. The skull is essentially lizard-like, both in its general form and in its structural details. The frontal is a paired bone. The premaxillæ send upwards mesial processes separating the external nares; the exclusion of the maxilla from these nares by the external ascending process of the premaxilla is apparent more than real, since the maxilla is prolonged forwards beneath this process, and comes into close proximity to the nostril. The supra-occipital enters into the foramen magnum. The palate fissured nearly in its whole length is strictly lacertilian. The presence of simple cylindrical teeth in the premaxillæ, of small, compressed teeth in the front of the maxilla and in the mandible, and of larger, more complex, compressed teeth behind these, foreshadow the incisors, premolars, and molars of the higher vertebrates. The vertebræ are opisthocœlous in the neck, planocœlous in the trunk and loins, and amphicœlous in the tail. In the neck and thoracic region of the vertebral column the ribs are forked. In the loins a simple unforked riblet is anchylosed to the end of the transverse process. The sacrum comprises five vertebræ. The ilium has a very long preacetabular process. The femur is shorter than the tibia; the inner trochanter is long and acutely pointed. The tibia has a stout præcnemial crest. The tarsus consists of two bones that together form a sinuous hollow upper surface, in which the tibia and fibula rest; the outer bone representing the os calcis supports both bones of the leg, whilst the inner, representing the astragalus, bears the tibia only. In two feet evidence of two elements of a distal row of tarsalia was found in the outer side of the foot. There are four functional toes with 2, 3, 4, 5 phalanges counting from the inner side of the foot, and a styliform rudiment of an outer metatarsal, devoid of phalanges. This alone demonstrates the generic distinctness of *Hypsilophodon* from *Iguanodon* in which, as is well known, the hind foot comprises only three functional toes. The ungual phalanges are sharply pointed. The sternum is rhomboid. The scapula and coracoid have a general resemblance to those of Iguanodon. The humerus has a considerable deltoid crest, and is shorter than the femur. The radius and ulna are shorter than the humerus. The ungual phalanges of the digits resemble those of the hind toes, but are smaller.

Physical Society, February 25.—Prof. G. C. Foster in the chair.—New Members: Prof. G. F. Fitzgerald, Trin. Col. Dublin, Mr. C. Richardson, Lieut. H. J. Dockrell, R.N., Mr. W. Ford Stanley, General H. Hyde, R.E., Mr. J. Buchanan.—Prof W. E. Ayrton, F.R.S., read a paper on Faure's accumulator, giving the results of experiments made by him and Prof. Perry on the efficiency, storing-power, and durability of the battery. The efficiency was got by measuring the power put in, and comparing it with that taken out, by means of Perry and Ayrton's voltameter and ammeter. The authors found that the cell has great resuscitating power if left insulated after all the current appears to have been discharged. Care had to be taken to see that the cell was quite discharged by letting it stand on open circuit for intervals and discharging between whiles. When this was done they found that the total loss for charges up to one million foot pounds need not be greater than 18 per cent. With slower charges they got a loss of only 10 per cent. As to the storage, a mean current of 18 amperes gave, after eighteen hours' discharge (six hours on three consecutive days), 1,440,000 foot pounds of work equivalent to 1 horse-power in forty-three minutes. The cell contained 81 lbs. of red lead, thus making a capacity of about 18,000 foot pounds per lb. of red lead. The cell showed no deterioration after two months of work.—Prof. Ayrton then described a new form of his dispersion photometer, which greatly reduces it in size and convenience. The principle of this instrument has already been described to the Society by the author. It consists in using a concave lens to disperse the stronger light, and thus obviate the necessity of putting it at a great distance if it is very powerful, such as an electric light. The powers of the two lights are compared by the eye in estimating the intensity of the shadows of a rod thrown on a white screen of blotting-paper by the two lights simultaneously. A sperm candle is used as the standard, and it is placed on a movable stand at an angle to the path of the other beam through the lens. Both the lens and candle can be shifted to and from the screen along a scale giving their distances, and the stronger beam is reflected from a small mirror. This mirror is ingeniously fixed so as to reflect the ray from the

same part of its surface whatever angle it is placed at, and thus the power of an electric light can be accurately given for every angle along which the ray travels from the lamp. Observations are taken through red and green glasses to get a better measure of the power of the light. Prof. Ayrton has found that ordinary air absorbs the green rays of the electric light very strongly, and hence, in order to get a proper test of an electric lamp, the photometer should not be far from the light. The new dispersion photometer shown is the only one admitting of this precaution. Mr. Shoolbred stated that he had found from experiment that the carbons of the Swan and Maxim incandescent lamps bore a much higher current without breaking when fed from a Faure accumulator than from a dynamo-electric machine. Prof. Ayrton corroborated this statement, and said that he had obtained a light of 800 candles from a Maxim lamp fed by an accumulator.—Prof. Sylvanus Thompson then read a paper on the electric resistance of carbon under pressure. It was generally stated that the resistance of carbon diminished under pressure, but he had found from recent experiments that the diminution observed was really due to the contact between the electrodes and the carbon. Under pressure there are more points of contact between the metal and carbon than without pressure. The result has an important bearing on the action of the carbon relay, rheostat, and microphone transmitter.—Prof. Ayrton pointed out that as carbon apparently diminished in resistance under a rise of temperature, this would seem to indicate it as a compound substance, since only simple substances seemed to increase in resistance with rise of temperature. Prof. Guthrie recalled that Dr. Moser had suggested that the alteration of the resistance of selenium under light was an effect of contact.—A paper by Mr. G. Gore was read, on the influence of the form of conductors on electric conductive resistance. His experiments were designed to show whether there was a difference of resistance in certain liquid conductors under the positive and negative current. None was discovered.—Dr. Hopkinson, F.R.S., read a paper on the refractive index and specific inductive capacity of transparent insulating media. He inferred from tried experiments and the electromagnetic theory that glass had a high refractive index for rays of very long wave-length. Dr. J. H. Gladstone suggested that the point should be tested by experiment, and that the method of photographing the red rays might be employed.—Mr. J. Macfarlane Gray explained that an objection to one result of his former communication to the Society, on the specific heat of steam, was really a confirmation of it, as Regnault's value was erroneous.

Chemical Society, February 16.—Prof. Roscoe, president, in the chair.—During the evening it was announced that the Council proposed Dr. Gilbert as the president for the coming year, Dr. Schunck and Mr. Griess as vice-presidents, and Drs. Atkinson and Japp, Capt. Abney, and Mr. O'Sullivan, as Members of Council, instead of Dr. Tidy and Messrs. Carteighe, Roberts, and Warington.—The following papers were read:—On benzylphenol and its derivatives, Part 2, by E. Rennie. The author has obtained and studied the following derivatives:—benzylphenol-sulphonic acid, mononitrobenzylphenol, amidobenzylphenol, dinitrobenzylphenol, nitrobromobenzylphenol. The same nitrobromo derivative is obtained whether nitric acid acts on the potassium bromosulphonate or bromine acts on the potassium nitrosulphonate. The formulæ of these substances must therefore be symmetrical. Benzylphenol is therefore a para derivative. The author quotes other evidence in support of this view.—On the Buxton thermal water, by J. C. Thresh. The author has made a most complete analysis of this water, and gives full details as to the methods employed.—On retrograde phosphates, by F. J. Lloyd. It has been long known that in some superphosphates the percentage of soluble phosphate originally present gradually decreases. The phosphate which has become insoluble is termed retrograde phosphate. The author has compared the different solutions recommended by Fresenius, Petermann, &c., for extracting these phosphates; he concludes that a cold ammoniacal solution of ammonium citrate containing 30 per cent. of citric acid is the most suitable solvent.—Contributions to the knowledge of the composition of alloys and metal work, for the most part ancient, by W. Flight. This paper contains analyses of some copper nickel coins of Bactria; some coins of ancient India, about 500 B.C., containing silver, copper, lead, &c.; a figure of Buddha, containing 4 per cent. of silver chloride; "Bidrai" ware and "Koft Gari" work from India; some iron and bronze implements from the Great Pyramid; copper spear-heads from Cyprus; a Hebrew shekel, various old Roman bronzes, &c.—On the dissociation of chlorine, by A. P. Smith and W. B. Lowe. The authors consider that their experiments prove that 1 gramme of chlorine at 6° C. becomes 0·744 grm. of chlorine at 1030° C.

Meteorological Society, February 15.—Mr. J. K. Laughton, M.A., F.R.A.S., president, in the chair.—The following gentlemen were balloted for and duly elected Fellows of the Society:—W. Aronsberg, J.P., W. G. Birchby, J. Rand Capron, F.R.A.S., P. Crowley, F.Z.S., W. W. Culcheth, M.Inst.C.E., D. Cunningham, M.Inst.C.E., F.S.S., S. Cushing, W. N. Greenwood, E. Kitto, J. Mansergh, M.Inst.C.E., G. Oliver, M.D., H. S. H. Shaw, Assoc.M.Inst.C.E., G. W. Stevenson, M.Inst.C.E., F.G.S., and W. H. Tyndall.—The papers read were:—Notes of experiments on the distribution of pressure upon flat surfaces perpendicularly exposed to the wind, by C. E. Burton, B.A., F.R.A.S., and R. H. Curtis, F.M.S. In the present state of aero-dynamics it seems to be impossible to make an *a priori* investigation of the distribution of pressure on a surface exposed to the impact of the fluid in motion without introducing such limitations as render the solutions arrived at widely divergent from the results obtained by the experiments hitherto made. The authors therefore proposed to themselves to attack the problem from the experimental side only, by a method which, as far as they know, has not been applied in the case of air, viz. the application of Pitot's tube, suitably modified in form to the simultaneous measurement of the pressures at the centre and at any en-centrically situated point of a pressure plate of known dimensions. The results of the preliminary experiments are given in the present paper.—The principle of New Zealand weather forecasts, by Commander R. A. Edwin, R.N., F.M.S.—The high atmospheric pressure of the middle of January, 1882, by H. Sowerby Wallis, F.M.S.—The electrical thermometer lent by Messrs. Siemens' Bros. for observing the temperature of the air at the summit of Boston Church Tower was also exhibited.

EDINBURGH

Royal Society, February 6.—Prof. Balfour, vice-president, in the chair.—Mr. John Aitken, in a paper on the Colour of the Mediterranean, and other waters, described a series of experiments which he had made last year as to the cause of the brilliant blue colour so characteristic of the Mediterranean and the Lake of Geneva. Two distinct theories had been advanced. The one explained the colour as due to reflection from small suspended particles which did not reflect the lower rays of the spectrum; the other as the result of the absorbent action of the water itself upon the white light before and after reflection from these particles. The former was shown to be inconsistent with the facts established by experiment, which could be fully explained upon the latter theory. The greater the number of white reflecting particles the greener the water appears to be, a fact which sufficiently explains the gradual deepening of the green to blue as one recedes from the shore. The waters of the Lake of Como owe their darkness to the absence of reflecting particles, as Mr. Aitken very ingeniously proved by scattering finely divided chalk in the centre of the lake, thereby producing a most brilliant blue. The brilliancy depends greatly on the colour of the suspended particles; and observations in other parts of the earth's surface go far to show that great brilliancy is usually found where white sand lines the shore. Thus the dullness of tint in our waters is to be referred to the dull colour of the small suspended particles. The author had also extended his observations to spring water, which was found to vary greatly in colour from dingy yellow to emerald blue. The paper was illustrated by experiments bearing out the views expressed, and led to a considerable discussion amongst the Fellows.—The Rev. Prof. Duns, D.D., read a paper on the surface geology of Middle Lochaber, giving a description of the peat, sand, gravel heaps, angular *débris* and boulders, which occur between the rivers Spean and Nevis, and along the west slopes of the Nevis Mountains. The paper was chiefly devoted to the boulders, their mineral character, size, position, angle to horizon, and striation being particularly noted. It was shown that the peat had been formed after the deposit of the sands and gravels, that the boulders occur *on* not *in* the heaps, that the position of boulders in the plain may have as much significance as those on mountain slopes, that all the characteristic glacial markings abound in this district, and that the bulk of the phenomena may ultimately be explained by the recognition of two movements—one outwards from Ben Nevis as a centre, and another (and preceding) inwards from the west, north-west,

or north-north-west.—Prof. Chrystal, in some suggestive remarks on dielectric strength, pointed out the error into which certain experimenters had fallen in imagining that the dielectric strength of a medium is at all determined by the maximum difference of potential that could exist between two conductors placed in it, the truth being that it depends on the dielectric tension (in Faraday's sense), that is, upon the resultant electric force or surface density at the point of rupture; and, in reference to this, described some experiments which he had lately carried out in conjunction with Dr. Macfarlane. From these it appeared that the difference of potential necessary to make a spark-pass between two charged balls was greater in the neighbourhood of a positively charged body, and less in the neighbourhood of a negatively charged body than when no such body was present. A strong magnetic field, on the contrary, had no effect on the dielectric strength of air, whether the lines of magnetic force were in the direction of or perpendicular to the direction of the electric force—even though the strength of the field was as much as 6000 absolute units. The main part of the paper was taken up with a discussion, from the Faraday and Maxwell point of view, of the experiments of Thomson, Macfarlane, De la Rue, and Baille. Amongst other theoretical considerations the effect of a particular variation in the specific inductive capacity was investigated. The "water-electrometer," with which he and Dr. Macfarlane had made some measurements last year, was referred to as being in all probability an effective and accurate instrument of research in electrostatic experiments—being at all events handier and more rapidly worked than an absolute electrometer of the ordinary construction. The results obtained by it he hoped ere long to lay before the Society.—A Latin diagnosis of new and little known phanerogamous plants collected in Socotra by Prof. Bayley Balfour was laid on the table.

PARIS

Academy of Sciences, February 20.—M. Jamin in the chair.—The following papers were read:—Meridian observations of small planets at Paris Observatory during the last quarter of 1881, by M. Mouchez.—On some applications of the theory of elliptic functions, by M. Hermite.—Double salts of mercury, by M. Berthelot. This relates to double iodides and chloroiodides.—Note on permanganate of potash considered as an antidote of snake poison, *apropos* of a publication of M. de Lacerda, by M. de Quatrefages. Vipers abound in Haute-Marne and some other departments in France (as is proved by the large numbers killed in consideration of a small premium on each viper). While the larger animals often recover from a bite, goats, sheep, and dogs often succumb. The effects on man, too, may be serious and even fatal. M. de Quatrefages desires the new method (some details of which he gives) to be made known. He also suggests it might be of use against the diseases treated by M. Pasteur.—Researches on a special influence of the nervous system causing the stoppage of exchanges between the blood and the tissues, by M. Brown-Séquard. Lesion of almost any part of the nervous system will cause this stoppage, which is more pronounced the more sudden the cause. The effects are chiefly these:—the venous blood becomes like arterial in colour; it holds less carbonic acid than normally; there are no convulsions before death; the body-temperature falls; the blood-vessels contract: after death, blood is found in the left heart, and the properties of the spinal cord, nerves and muscles, persist.—Action of high atmospheric pressures on the animal organism, by M. de Cyon. To M. Bert's apparatus he added arrangements for measuring the variations of blood-pressure, pulsations, and respiratory movements, and for stimulating sundry nerves. He finds that oxygen is not a special poison for the organism; animals die at high atmospheric pressures, simply because, the carbonic acid (the chief excitant of the vasomotor and respiratory centres), diminishing considerably, circulation and respiration stop; the former, because of too great lowering of blood-pressure; the latter, because of apnea. The heart-beats are accelerated for the same reasons; the oxygen increasing the action of the accelerating nerves, while the moderating action of the pneumogastric is lessened through failure of carbonic acid.—On the parasite of malaria, by M. Richard. This has been called by M. Laveran, *Oscillaria malariæ*. M. Richard has traced its development, in the red corpuscles, into a collar of dark granulations (displacing the hæmoglobin). Escaping, it appears like a flexible rod or whip; the thin end sometimes gets caught, and the organism then oscillates violently as if to free itself. In about an hour it dies. Generally, however, the parasite is inert. The parasitiferous corpuscles lose elasticity and become very viscous; hence they accumulate in the capillaries.—A new apterous male in Coccidians (*Acanthococcus auris*, Sign.), by M. Lichtenstein.—Observations of comet b = III. 1881, at Paris Observatory, by M. Bigourdan.—On the distribution of protuberances, faculæ, and solar spots, observed at Rome during the second and third quarters of 1881, by M. Tacchini. The faculæ extended to higher latitudes than in the first quarter; and protuberances were observed nearer the poles. In winter and summer a preponderance of protuberances appear in the south; in spring and autumn, in the north.—Solar spectroscopic observations at the Royal Observatory of the Roman College during the second and third quarters of 1881, by M. Tacchini. A continuous increase (not very rapid) of solar activity is indicated. In July the protuberances showed a secondary minimum, and the spots a maximum, and M. Tacchini attacks M. Faye's doubts as to this.—On the distribution, in the plane, of roots of an algebraic equation, of which the first member satisfies a linear differential equation of the second order, by M. Laguerre.—On the theory of uniform functions of a variable, by M. Mittag-Leffler.—On the integration of the equation $A\dfrac{d^n\phi}{dt^n} + \left(\dfrac{d^2}{dx^2} + \dfrac{d^2}{dy^2} + \ldots\right)^n \phi = 0.$—On the practical solution of the problem of transport of force to great distances, by M. Levy. He proposes to have n generators connected in quantity, placed in n branch circuits, all connected with two points taken arbitrarily in the principal (biflar) circuit.—On the relative motion of the earth and the ether, by Mr. Michelson.—Compass without resistance, for measurement of intense currents, by MM. Terquem and Damien. This consists of a land-surveyor's compass, under which is a first band of copper for circulation of a current; under this a series of rectangular pieces of wood and other copper bands, the whole borne on a central rod. Two vertical bands bring the current into any one of the horizontal ones, according to the position in which you fix a peg.—Hydrodynamic experiments, &c. (continued), by Decharme.—On the saturation of phosphoric acid by bases and on chemical neutrality, by M. Joly.—On ferricyanhydric acid, by M. Joannis.—Action of iodine on naphtaline at a high temperature, by MM. Bleunard and Vrau.—On the blue and green coloration of dressings, by M. Gessard. He isolated the organism which produces the blue pigment (pyocyanine), and afterwards changes it to green.—Troubles of equilibration in young children deaf through otopiesis; their disappearance on return of hearing, by M. Boucheron.—On the evolution of teeth of Balænides, by MM. Pouchet and Chabon.—On the optical properties of crystalline bodies presenting the spherolithic form, by M. Bertrand.—M. Mouchez made some remarks on presenting a magnetic map of Russia by Col. de Tillo.

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THURSDAY, MARCH 9, 1882

VIVISECTION

THE discussion on this subject which has been carried on during the last few months in the *Nineteenth Century* and *Fortnightly Review* has now, we think, proceeded sufficiently far to render it desirable that we should give our readers a short summary of its progress. But as there are altogether some twelve or fourteen articles to be dealt with, we shall only have space to supply a general analysis of the facts and arguments, without being able to give an abstract of each article separately.

As regards the general tone or manner of pleading, there can be no doubt that the advantage inclines largely to the side of the physiologists; for while—with perhaps a slight exception in the case of some of the passages in the essays by Prof. Owen and Dr. Wilks—the physiologists state their arguments in a calm and tolerant spirit, the essays on the other side—with the exception of one by Mr. Hutton—present, in a painfully marked degree, the features of bitterness and ill temper. But, disregarding this conspicuous difference in the style of writing, we shall endeavour to give an analysis of the arguments on both sides, the impartiality of which shall not be affected by the fixed opinion which this journal has always held upon the subject.

The *utility* of Vivisection is upheld by Sir James Paget, Prof. Owen, Dr. Wilks, Dr. Carpenter, Sir William Gull, Mr. Fleming, Dr. Brunton, and Dr. Yeo. This is done, not merely by stating the general truth, obviously *a priori*, that "it would be more reasonable to hope to make out the machinery of a watch by looking at it, than to hope to understand the mechanism of a living animal by mere contemplation"; but chiefly by enumerating instances in the past history of research where important advances of knowledge have been made by vivisection, and could not have been made otherwise. The cases mentioned are very numerous, so we must restrict ourselves to re-mentioning the more important.

Sir James Paget says—and on such a topic he is entitled to speak with at least an unsurpassed authority—"Before Hunter's time it is nearly certain that ninety-five out of a hundred persons who had aneurism of the principal artery of the lower limb died of it. . . . At the present time it is as certain that of a hundred persons with the same disease less than ten die," and if we contemplate cases of aneurism in all other arteries, as well as deaths from bleeding after large operations, the saving of life due to Hunter's experiments is seen to be "very large." But Sir James does not needlessly prolong his article by enumerating specific instances; he says: "others have already abundantly illustrated them; I will rather suggest some general considerations on the whole subject. Looking back over the improvements of practical medicine and surgery during my own observation of them in nearly fifty years, I see great numbers of means effectual for the saving of lives and for the detection, prevention, or quicker remedy of diseases and physical disabilities, all obtained by means of knowledge to the acquirement or safe use of which experiments on animals have contributed. There is scarcely an operation in surgery of which the mortality is now more than half as great as it was forty years ago; scarcely a serious injury of which the consequences are half as serious; several diseases are remediable which used to be nearly always fatal; potent medicines have been introduced and safely used; altogether such a quantity of life and of working power has been saved by lately-acquired knowledge as is truly past counting. And in these advantages our domestic animals have had due share of the improvement of veterinary medicine."

The next paper in the series is by Prof. Owen, and is concerned mainly with the history of the indispensable part which vivisection played in Harvey's discovery of the circulation of the blood and in Hunter's experiments on the ligature of arteries. Although the latter topic occupies common ground with a part of Sir James Paget's paper, the overlapping due to independent writing is not to be regretted, because Prof. Owen traces the history of the subject into more detail, in order to expose the fallacy of the anti-vivisectionists, who say that Hunter was anticipated in his results by other surgeons working by other methods. This, we think, he is completely successful in doing—so much so, indeed, that Mrs. Algernon Kingsford M.D., who supplies an essay in a succeeding number of the *Nineteenth Century* on "The Uselessness of Vivisection," while disputing Sir James Paget's mere statement of the fact that the surgical treatment of aneurism is due to Hunter's experiments on deer, nevertheless finds it convenient entirely to ignore the historical details which are given by Prof. Owen; and the same remarks apply to this lady's treatment—or rather evasion—of the facts concerning Harvey's discovery of the circulation of the blood.

Dr. Wilks makes utility the central portion of his argument, and gives so many instances of the service which vivisection has rendered that we cannot here quote them. The instances he refers to concern the heart, circulation, functions of the brain, spinal cord, and nervous system generally, including its influence over the heart, lungs, stomach, kidneys, bladder, skin, and muscles, &c. "What," he asks, quoting from Prof. Humphrey, "has been the influence of this upon medical treatment? . . . Take away the knowledge which we have received through vivisection, and conceive what a chaos would be our knowledge of the human body, and our ideas of the treatment of the diseases of the human body; you can scarcely conceive to what we should be reduced. Every man in the whole history of medicine, every man who has made real advances in the knowledge of the workings of the human body, has done it through vivisection."

The utility of vivisection is further shown by Sir W. Gull, Dr. Carpenter, Mr. Fleming, and Dr. Brunton. The former alludes to the discovery of the lymphatic system, and of the capillary circulation, to "the great advances made by Boyle, Mayow, and Lower, in the same century"; and more especially to the work of Claude Bernard on animal heat. This is specially alluded to in consequence of Miss Cobbe in her article "writing of the title of Claude Bernard to be honoured by physiologists, saying that such title is, at least partly, based on the invention of a stove which should enable him to

watch the process of 'baking dogs alive'"—a statement "calculated, if not intended to convey a totally false impression both of the purpose and the details of these memorable experiments." The importance of the latter in relation to preparing the way for a full understanding of the deadly phenomena of fever is then clearly exhibited, together with the fact that "if a dog be put into a heated chamber and his blood be raised to the temperature of a bird's, he quickly dies"—so that the "baking alive" really means raising the temperature of the dog's blood through ten degrees. Every year in this country alone 40,000 persons die of scarlet and typhoid fevers—"baked alive" by them; and this constitutes but a small part of the annual deaths in which exalted temperature is a fatal factor. No wonder therefore that medical men pay tribute to the memory of Bernard for opening the way to an understanding of the subject, such that "this fiery furnace, with its uncounted millions of victims, science hopes to close; and it is quite reasonable to believe that the time will come when fever will be as much under our control as are the movements of a chronometer." When to this it is added that "Bernard, in these experiments on fever, sacrificed two pigeons, two guinea-pigs, less than twenty rabbits, and six dogs," we cannot think that the selection by Miss Cobbe of her favourite atrocity is a very fortunate one.

Sir William Gull proceeds to consider the great gains which have accrued to medical science through some of the experiments of Magendie, and those of Marshall Hall; and Dr. Brunton, in a singularly telling article, shows how in an ordinary diagnosis it is impossible to advance a step without using at every point knowledge gained by experiments on animals. He also appeals to the British Pharmacopœia to prove that to vivisection "we owe the introduction of the most valuable of our new remedies." Between the editions of 1864 and 1867 there are added seven new drugs, of which at least the two most useful—viz. carbolic acid and physostigma—are due to vivisection. Again, between the editions of 1867 and 1874 we find eleven new remedies, of which the three most useful—pepsine, chloral, and a nitrite of amyl—were discovered, or their uses perfected, by experiments on animals. So that, without considering "many other new remedies which are still on their trial, and which will, in all probability, be added to the next edition of the Pharmacopœia, it is a matter of already accomplished fact that "the introduction of nearly all the most valuable new remedies which have been added to the Pharmacopœia since the year 1864" have been discovered by vivisection.

Still confining ourselves to the question of utility, we have next to notice the essay by Mr. Fleming, who undertakes to show that even in the exclusive interests of animals themselves, it is most ill-advised to tie the hands of science in its investigation of disease. Anthrax alone, in a single district of France, kills about 178,000 sheep a year, and in 1857 100,000 horses perished from this disease in Russia alone. Many other equally startling statistics are given; and now, owing to the laboratory experiments of Pasteur and others, "there is no longer any doubt as to the value of protective inoculation;" and the same method has been found equally effectual in protecting poultry from "fowl-cholera." It is not improbable that hydrophobia, glanders, cattle-plague, pleuro-pneumonia, swine-plague, sheep small-pox distemper, and tuberculosis, will all admit, by modifications of the same method, of being similarly brought under control.

In connection with utility we have space only to refer to one other case, but this the most conspicuous. We allude to the work of Lister, which, as Dr. Carpenter says, "constitutes by far the greatest single improvement ever introduced into surgical practice," and which, as Dr. Wilks says, "has been the means of saving the lives of thousands every year, both in England and on the Continent." Yet Prof. Lister "found that he was obliged to discontinue his important investigations or conduct them abroad. He chose the latter course, and went to France; for, he said, 'even with reference to small animals, the working of the Act is so vexatious as to be practically prohibitory of experiments by a private worker like myself, unless he chooses to incur the risk of breaking the law.'"

Such, then, is a brief abstract of the evidence on the head of utility. This evidence is not disputed by the writers on the other side, with the exception of Miss Cobbe and Mrs. Kingsford; but the writings of these ladies upon the subject are so extravagant and ill-advised that even an ignorant reader must feel their judgment upon this head to be valueless.[1] With the unanimous opinion before them of the International Medical Congress, the British Medical Congress, and of all persons whose knowledge of physiological science entitles them to be heard on this point, Lord Coleridge and Mr. Hutton adopt a line of argument which, so far at least, is more judicious. Lord Coleridge says: "I will not dispute with them as to the fact. A lawyer ought at any rate to know the folly of encountering an expert without the knowledge necessary for success in the conflict. I deny the practical conclusion sought to be drawn from it on grounds of another sort, which appear to me of overwhelming force." And Mr. Hutton says: "I have never believed all these experiments to be scientifically, or even medically, worthless," and he allows that some of them (inoculations) have been "*very* fruitful."

We may, then, take the evidence of utility as being beyond all question by any reasonable and impartial mind. Next let us consider the arguments which are adduced against vivisection other than the suicidal one of inutility. These may broadly be classed under two headings—those which assert that vivisection is immoral, and those which assert that it is irreligious.

In considering these arguments we may best begin with the essay of Lord Coleridge, and in doing so we find it difficult to strike the balance between our respect for the

[1] The authority of Sir W. Fergusson and of Sir Charles Bell is indeed quoted in support of the uselessness of vivisection to surgery, but their opinion on this subject—or rather the opinion of the former, because the latter did not live to see all the results alluded to by Sir James Paget—is so immeasurably outweighed by professorial opinion in general that it is interesting chiefly because of its isolated character The only other feature in these papers that deserves the name of argument is that inference from the results of experiments on animals to the physiological economy of man may be erroneous, or even misleading. But what does this argument show? Surely not that, *for this reason*, experiments on the nearest analogues of the human body should not be made. No instance can be pointed to of a fatal or even deleterious mistake having been made as a consequence of any such erroneous inference, nor is it at all likely that such an instance can ever arise.

man, and our astonishment at the feebleness of his production. Taking as fair and unbiased a view as we can, it appears to us that, as a mere matter of pleading, if this is all that can be said, even by a Lord Chief Justice, in favour of abolishing physiological experiment, the physiologists could not well find a better advocate. Indeed, as the paper throughout shows ill-concealed evidence of intolerable irritation, its manner, as well as its matter, suggests that the writer himself begins to feel that he has committed a mistake in too early and too warmly espousing an irrational cause. But, be this as it may, we shall endeavour to state, as fairly as we can, the course of his argument.

We have already seen that he expressly disregards the question of utility, and bases his argument "on grounds of another sort." These grounds are that, even if practically useful to the extent claimed by physiologists and medical men, knowledge gained by vivisection ought not to be sought or tolerated, inasmuch as it is "unlawful," or "pursued by means which are immoral." Here, at least, we have a definite marking out of the "grounds" on which Lord Coleridge justifies his determination, as he says, "earnestly to support the Bill which Mr. Reid is about to submit to the House of Commons," *i.e.* the Bill for total abolition. We think, therefore, that it becomes a matter of importance clearly to define what is here meant by "immoral" and "unlawful." The only indication given by Lord Coleridge of such a definition is as follows: "I deny altogether that it concludes the question to admit that vivisection enlarges knowledge; I do not doubt that it does, but I deny that the pursuit of knowledge is in itself lawful; still more do I deny that the gaining knowledge justifies all means of gaining it." So far as these general propositions are concerned the principles of morality are obvious, and would be disputed by no one; but now for the special case of vivisection. "To begin with, proportion is forgotten. Suppose it capable of proof that by putting to death with hideous torment 3000 horses you could find out the real nature of some feverish symptom, I should say without the least hesitation that it would be unlawful to torture the 3000 horses." Now in the first place, supposing—as we must suppose if the illustration is to stand as argument—that the knowledge gained concerning the "feverish symptom" is to be knowledge useful in the saving of human life, we think that a truer note of "morality" is struck by Sir James Paget when he writes of a man whom he saw die under chloroform faultlessly given, "he was so good and generous a man that I felt it would have been right to kill a hundred animals either to save his life or to find out why he died, and to be able in the future to avert so awful a catastrophe." And if it is sound morality thus to feel that one hundred animals may be sacrificed to avert one such catastrophe, can it be otherwise to feel that three thousand animals may be "lawfully" sacrificed with the certainty of gaining assured knowledge—for this is the argument—which is to save many human lives?

But, in the second place, this brings us to the question of proportion, which is rather vaguely presented in Lord Coleridge's illustration. And on this question the physiologists are perfectly ready to join issue; in fact it is one of their strongest positions, and cannot be more tersely stated than it is by Dr. Carpenter, whose very temperate and most judicious essay on the "Ethics of Vivisection," appears in the same number of the *Fortnightly Review*, and in this, as in several other points, anticipates Lord Coleridge's arguments in a manner singularly complete. He here says: "My argument then, is that if in all the foregoing cases (*i.e.* of animal labour, &c.) the moral consciousness of those who consider themselves most elevated in the scale of humanity justifies the infliction of animal suffering for what is obviously a real benefit to man, even though the continuance of such benefit involves *the constant renewal of the suffering*, much more is *a temporary and limited infliction* justifiable, for the discovery of such scientific truths as have a clear prospective bearing on human well-being, moral as well as physical, since every such discovery, once established, is *a boon for ever*, not only in its direct applications, but in serving as a stepping-stone to further discoveries, which may prove of still more priceless benefit."

Again, Sir W. Gull very properly asks: "Why does Lord Coleridge, for the purpose of his argument, select *horses*, and why so large a number as three thousand? He must know that the horse has been but little experimented upon . . . so that the supposition of *three thousand horses* and *hideous torment* is an exaggerated expression, out of proportion to the facts—misleading, and in no way conducive to a fair judgment of the question at issue." The truth is, it would be better for the cause which Lord Coleridge has embraced if "proportion" *could be* "forgotten"; for the strongest point in the counter-argument is that there is no comparison between the ratios—as Pain inflicted on animals for other purposes : Pain inflicted by Vivisection : : Prevention of Pain resulting from the former : Prevention of Pain, or other utility, resulting from the latter. And therefore, just because they do *not* forget the question of proportion, physiologists maintain that it is unreasonable in humanitarians to attack the only kind of "cruelty" that is really fruitful—and fruitful a hundredfold—in mitigating pain, not only in the case of man, but, as Mr. Fleming shows by his very astonishing tabular statements, also in the case of animals. Yet this essential argument has wholly escaped the observation of Lord Coleridge, and as a consequence he entirely misapprehends the subordinate argument of the physiologists who point to cases of admitted, wholesale, and useless kinds of cruelty as those towards which the energy of humanitarians should be directed. For he represents this argument as saying: Because there are many other kinds of cruelty of greater magnitude in the world, therefore "something which, *consistently with all this argument*, may be horribly cruel and utterly worthless, is to be let alone." Truly Lord Coleridge may be "positively mortified to have to notice" such an argument as this; only no one, so far as our knowledge extends, has ever advanced it. No physiologist could be simple enough to defend vivisection on the supposition that it "may be horribly cruel and utterly worthless." The real argument to which Lord Coleridge refers is this:—Because there are many practices permitted which are without question horribly cruel and utterly useless, therefore it is irrational folly to waste the energy of humanitarian feeling in a warfare against the only kind of pain-giving practice which is directed towards the mitigation of pain, and which has

already been successful in this its object to a degree *out of all proportion* to the pain inflicted.

If it is true, as the physiologists agree with Lord Coleridge in maintaining, that the ethics of vivisection turn upon this question of proportion, it becomes morally as well as logically incumbent on all those who take an active part in the anti-vivisection movement to make themselves acquainted with the facts by which alone this question can be determined. We therefore recommend all who are interested in the subject to read the very powerful essay by Prof. Gerald Yeo in the current number of the *Fortnightly Review*. This essay, when contrasted with that of Lord Coleridge or Miss Cobbe, exhibits in a striking manner the difference between knowledge and imagination, and therefore we do not think it can be said that the measured censure bestowed by this writer is too strong where he thus alludes to the above illustration of 3000 horses put to death by "hideous torment"—"I should have thought it impossible that a man who declares, 'I am not conscious of any distorting influence on my judgment; I have no anti-scientific bias,' could have suggested a case so horribly improbable. The extravagant irrelevancy of such a sacrifice, and its utter incompatibility with anything that can be called physiological research, are so manifest as to need no comment. Surely the writer cannot really imagine that such sheer brutality is within the range of possibility; or does he merely make the hideous suggestion in order to frighten those who have no knowledge of the matter? I refer to this sentence simply as an illustration of how unfounded and inaccurate ideas sometimes originate. For there can be no doubt that the mere mention of this appalling problem by such an authority, however repugnant it may be to common sense, cannot fail to leave some very unpleasant traces in the minds of many who imagine that a Lord Chief Justice would not undertake to write articles in a leading review, unless he had some accurate knowledge of the practical bearings of the subject."

Prof. Yeo has written his article in order to place such knowledge within reach of the general public, and he has evidently done so with the honest purpose of being "accurate." He says: "The exact relation of painful experiment to physiology may be best seen in a short analysis of physiological methods. Practical physiology is made up of four departments, in which its histological, chemical, physical, and vital branches are respectively studied. . . . Thus in fully three-quarters of practical physiology living animals do not appear at all. All vivisections are found in the fourth branch of physiology, but even here they form a very small part, for a large number of experiments on living animals (including man) are carried on without either cutting or pain." Taking then the subdivision of possibly paingiving experiments, Prof. Yeo gives an analysis of the Parliamentary Reports during the last five years, in order to get at the precise number of paingiving experiments which, during that time, have been made in this country. From these figures it appears that about three-fourths of the possibly paingiving experiments were rendered painless by the administration of anæsthetics, and of the remaining fourth, four-fifths were "like vaccination or the hypodermic injection of morphia, the pain of which is of no great amount." The tabular percentage is, therefore, as follows:—

Absolutely painless	75
As painful as vaccination	20
,, healing of a wound	4
,, surgical operation	1
	100

Thus, since the statistics have begun to be taken under the new Act, it is a matter of numerical statement that in this country only 1 per cent. of experiments in vivisection are attended with pain greater than that caused by pricking with a needle or healing from a cut. Therefore we must here repeat our judgment that in this discussion it is shown to be the anti-vivisectionists, and not the physiologists, who have "forgotten" the question of "proportion"; for nothing can prove more conclusively than these figures that Lord Coleridge's statement of the case becomes true only if it is quoted with inverted meaning—"There is no proportion between the end and the means."

But Prof. Yeo is speaking of physiology as practised in England. Foreign usages he does not feel that it devolves on him to defend, and he appears to have an easy task where he shows that all the array of horrors which the anti-vivisectionists have been able to collect from the past history of physiological research have been derived from abroad. And it appears but fair argument to draw this distinction. This country cannot legislate for foreign physiologists, and no particle of evidence has ever been forthcoming to show that English physiologists are less scrupulous than the rest of their countrymen in their regard for animal suffering. On the contrary, long before the agitation began these physiologists themselves at the British Association formally laid down and formally accepted a carefully worded code of rules (quoted in the essay by Sir W. Gull) to guide their action with a view to minimizing of pain; and they have never, either collectively or singly, objected to legislation against possible abuses, while many of them have distinctly expressed their approval of such legislation. The long array of atrocities which constitutes the bulk of Miss Cobbe's paper is therefore quite irrelevant to any question in which this country is concerned. At most she can only argue, as Mr. Hutton argues—Because such things have happened on the Continent they *may* also possibly happen in England; and the answer is, By all means let there be legislation to guard against the possibility. And Prof. Yeo proves, we think conclusively, that the existing Act is abundantly sufficient for this purpose.[1]

Another argument on the score of morality that has been advanced is one which is well and temperately stated by Mr. Hutton. He says: "You cannot take a step so certain to stimulate the thoughtless cruelty which still survives among us, as to sanction the deliberate infliction of a great mass of thoughtful cruelty, justified only by the prospect of ultimate benefit to man at the cost of untold agonies to his miserable fellow-creatures." But here, if the mis-statement of the "proportion" question presented by the concluding words is disregarded, it is evident that the point of ethics raised must be determined solely by consideration whether the "thoughtful cruelty" is *cruelty*—*i.e.* pain inflicted without an adequate

[1] It seems to require pointing out to Lord Coleridge and Miss Cobbe that to quote a brutal expression from any foreign physiologist is no argument for the *abolishing* of physiological experiment. Even if such expressions were English, or if the Royal Commission had found cases of abuse to occur in this country, there would be no such argument.

moral justification. And to assume that it is so is to beg the whole question.

Only one other argument of an ethical kind remains to be considered, and we are sorry to say that it has been advanced by Lord Coleridge—sorry because it is so childishly weak. It is the old argument that if the advancement of knowledge is taken to justify the vivisection of animals, as much or still more should it be taken to justify the vivisection of men; and in view of the horrible possibility thus supposed, Lord Coleridge exclaims—"I hope that morals may always be too much for logic; it is permissible to express a fear that some day logic may be too much for morals." Logic! Only on the assumption that an animal is a rational and a moral as well as a sentient creature, and that its reason and its morality are on a level with those of man, would the argument become logically valid; and it is just because the physiologists *do* "consent to limit the pursuit of knowledge by considerations not scientific but moral," that they are obliged to draw the same logical distinction between men and animals as that which is drawn by the Legislature.

Coming lastly to the side of Religion, Mrs. Kingsford concludes her article with a paragraph which we think worth quoting, as it may serve to indicate the value of her opinions generally: "If I should be asked what is the real position taken by the leading champions of 'free' vivisection, and concealed from the public under the plea that the practice conduces largely to the benefit of humanity, I would define it thus:—

"1. Repudiation of the religious and sympathetic sentiments, and of the doctrine of man's moral responsibility as superstitious and untenable.

"2. Deliberate determination to dissociate themselves from all but those who join in such repudiation; and to make the practice of experimental physiology on living animals a rallying-point for the expression of that determination."

Surely it must appear to Mrs. Kingsford that these "leading champions" are adopting somewhat roundabout means to secure their very remarkable ends.

Lord Coleridge asks: "What would our Lord have said, what looks would He have bent upon a chamber filled with 'the unoffending creatures which He loves,' dying under torture deliberately and intentionally inflicted?" And Prof. Yeo answers: "I cannot imagine any such chamber of horrors, any more than I can his other hideous suggestion;" and adds that concerning the real facts of vivisection as performed in this country, "my conscience unhesitatingly tells me that it would have met with the full authority and approval of our Lord. . . . And I like to bear in mind the texts which seem to have an accurate bearing upon the subject, 'Ye are of more value than many sparrows,' 'How much then is a man better than a sheep?'" Similarly Sir W. Gull and Dr. Carpenter support physiological research on grounds of Christianity and Theism, and it is evident that the religious side of the question really hinges on the ethical. If vivisection is cruel, it is also irreligious; but if it is the highest mercy, physiologists may claim, though from those to whom their work has been of priceless value they may not always receive, the beatitude of the merciful.

FISHER'S "EARTH'S CRUST"

Physics of the Earth's Crust. By the Rev. Osmond Fisher, M.A., F.G.S. (London: Macmillan and Co., 1881.)

MR. FISHER is well known to geologists as the writer of various important papers on Mountain Chains, Terrestrial Heat, and other physical phenomena of the earth. He has in this volume not merely collected these papers, but added so much new matter that they form only a small part of the book. It deals with those regions whither we cannot penetrate, and might be called a Treatise on Concealed Geology.

It has been made a reproach to geologists that their mathematics never get beyond the Rule of Three. Mr. Fisher may redeem them from the reproach. Indeed an unmathematical reader, when he sees pages covered with symbols, may be tempted to close the book in despair and imagine it a case of μηδεὶς ἀγεωμέτρητος εἰσίτω. However he would not act wisely. If he read steadily on, only omitting such calculations as he cannot understand, he will obtain many fruitful ideas, and follow several chains of sound and careful reasoning.

After a discussion of the rate of increase of temperature met with below the surface of the earth (which he concludes by adhering to the customary view of a uniform rate) Mr. Fisher reprints his former calculations of the enormous and overwhelming pressure to which the crust of the earth would be subjected, if the interior shrank away from it by contraction. The pressure would be such as the strongest rocks could not resist. The engineers of the St. Gothard Tunnel were almost baffled in attempting to sustain less than a mile's thickness of yielding rock. What arches or rings, what metal or granite would stand two thousand times that stress? There can be no doubt therefore that contraction is a cause adequate in intensity to contort any strata however thick, or uplift any continent however lofty. Adequate in intensity most certainly; but has it been sufficient in quantity? This question, Mr. Fisher next considers. The answer will probably surprise many geologists.

When the earth first formed a solid crust with a glowing nucleus reaching to within a few feet of the surface, the nucleus would begin to cool and contract. As it shrank, the shell settling down on to it must crush itself into wrinkles. As successive internal portions solidified and were united to the solid crust, the remaining nucleus would continue to shrink, and the volume crushed out from the crust in process of accommodating itself would grow correspondingly greater. The wrinkles would be magnified. From Sir W. Thomson's formulæ for the internal temperatures of a cooling globe Mr. Fisher calculates the total volume of the wrinkles that could have been produced by now. He shows that this cannot possibly be so much as the fifteenth part of the volume of continental elevations above the sea bottom: more probably not even the sixtieth part. Though he considers the nucleus fluid, while Sir W. Thomson thinks the whole globe would have been solid or nearly so, this does not seem to affect the correctness of the conclusion. At the same time this cause, inadequate for continents, might yet be abundantly sufficient for the existing mountain chains, and for many predecessors of them.

The theory of the earth's constitution put forward in this volume is that the surface on which we stand belongs to a crust some thirty miles thick, floating on a substratum of slightly greater density. Below this substratum *may* be a solid nucleus, *must* be if Sir W. Thomson's proof of the earth's rigidity be accepted; but this book does not profess to go deeper. The floating crust cannot be supposed to possess much strength, so that the weight of mountain chains would break through it, unless they have beneath them corresponding protuberances on the under side of the crust, which shall support them by the additional buoyancy so produced. A plastic crust under compression would yield above and below, and thicken, as two pieces of hot sealing-wax spread out when pressed together, so as to give rise to such double bulges as are supposed. However, it is shown that even on this theory contraction cannot have produced the whole of existing terrestrial inequalities of surface, and could hardly even have lifted the continents above the sea-level. The general result of these suppositions would be that the crust beneath the ocean basins must be denser and thinner than that beneath the continents. To every ocean depression must correspond a similar larger concavity below, and continental elevations must have much greater protuberances answering to them on the under-side. Thus, could we strip off the crust like a hide, and turn it over, we should find the under-side reproducing the upper-side, only with every feature magnified.

This conception may be deemed at first sight strange and wild, yet it certainly affords an easy explanation of one or two rather singular phenomena. It was found during the Indian Survey that the mountain mass of the Himalayahs attracted a plummet much less than it ought to do, and that the cavities which contain the waters of the ocean, instead of causing a diminution of attraction, show an increase. Now it is shown that the protuberances of light material below the former and the concavities filled with the denser substratum below the latter would produce exactly such results. Also the hemisphere of water, which maintains its position in spite of continental attraction, is thus sufficiently accounted for. Again, since the floating crust must sink wherever weighted, and rise wherever material has been removed, we see how vast thicknesses of sediment might be accumulated without much perceptible change of depth, and mountains suffer continual degradation, and yet never be entirely effaced.

Another remarkable argument is derived from the observations in the St. Gothard Tunnel, which show that the rate of increase of internal temperature is slower there than beneath plain countries, and slowest where the mountain is highest. This should not be the case, perceptibly were the earth cooling as a uniform solid. Assuming these rates to be uniform, and allowing for the cold due to the elevation, it is easy to calculate the depths at which any particular temperature would be reached. If there be a molten nucleus its surface should be a surface of uniform temperature. But the depth at which a temperature of fusion can be reached will be found far greater under the mountains than under the plains. Hence, says Mr. Fisher, the solid crust must have protuberances below, answering to the mountains above.

This argument is weighty. It approaches near to demonstration. If this slower rate of temperature-increase below mountains were satisfactorily made out, and if we could be sure that the rate remained uniform at all depths, the existence of such protuberances would be almost proved. It is difficult to see what other supposition could be made. However, with the wide discrepancies at present experienced in the observations of such temperatures, and with the evidence that exists for a rate depending on the depth, a sceptic is not quite compelled to assent.

No theory of the earth's crust can be complete which does not provide the machinery for earthquakes and volcanoes. Mr. Fisher, for this purpose, supposes his subterranean fluid to contain, in intimate union with itself, vapour in considerable quantities. This vapour is to be retained in the fluid by the superincumbent pressure, as gas is in the liquid of a soda-water bottle, and will, if such pressure be removed, be disengaged from the molten matter as the gas disengages itself when the cork is drawn, though much more slowly, by reason of the viscosity of the fluid. This agrees with the view taken by Prof. Judd in his recent volume on Volcanoes. It will be a novel idea for many of us to imagine the earth like a globular bottle of effervescent liquid, and its crust like ice covering a lake of aërated-water. But such a constitution would account for many of the phenomena of eruptions. The earthquakes which usually herald them, the rise of molten material in a fissure, the existence of permanently liquid lava like that in Kilauea, the quiescence of neighbouring vents, the growth, death, and revival of a volcano, all follow as natural consequences. The difference in the lavas ejected from adjacent craters and the supposed order of succession in the products erupted are also accounted for, but not so satisfactorily. The theory is a very important one, and appears on the whole the most satisfactory that has yet been propounded.

It is natural to suppose that the emission of the vapour from this substratum would tend to produce a contraction of the nucleus. When we consider how far the volume of the ocean exceeds that of the continents it is surprising to be told in the chapter on the Extravasation of Water that this supposition cannot account for them. However it will be found on examination that much depends on the hypothesis. The supposition made is not local emissions of liquid producing cavities, but a general exudation and consequent crumpling of the crust. The analogy is not to the subsidences in Cheshire, where brine has been removed, but to the wrinkled skin of an apple as it dries.

The reader of this volume must bear in mind that most of the numerical results from time to time obtained and used are deductions from assumed data. and not independent truths. Such is a statement which often occurs in the calculations, that the contraction required to produce the existing inequalities of the earth's surface is 0·0105. He must also distinguish real confirmations of the theory such as the deviations in the plumb-line and the slower subterranean temperature-increase in the neighbourhood of mountains, from mere appearances of coincidence in numerical results. The latter are in several cases necessary consequences of identical assumptions. The agency of intruded dykes in producing elevation and compression does not seem altogether a natural one. We may conceive the crust passing down into fluid, but not

so readily that the fluid should pass again into a solid centre. Another formidable difficulty is that a subterranean ocean must be subject to tides, as much as the sea would be though covered by ice. This is passed over somewhat lightly with the suggestion that viscosity may be sufficient to obscure all tidal phenomena. Doubtless, too, other difficulties will start up for which it may not be easy to find a solution. But every theory is sure to present difficulties. Time must show whether they multiply or die away.

One or two points do seem to emerge from this assemblage of calculations as fairly clear, and established on tolerably firm foundations. Such are, that contraction of the earth by cooling is inadequate to the production of its greater inequalities. The earth cannot be a mass quite so homogeneous as on the theory of having cooled from a perfect fluid it is often assumed to be. There must be subterranean irregularities of density. Besides these, the phenomena of volcanoes seems to be explained best, as yet, by the existence of vapours and gases in intimate mixture with the materials below its crust. And a substratum plastic, if not fluid, will account for many facts which are ordinarily very perplexing. But, to quote from a striking quotation made in the volume itself, "Of all known regions of the Universe the most unsafe to reason about is that which is beneath our feet." E. HILL

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Vignettes from Nature

ANXIOUS that popular scientific literature, especially that which deals with the Evolution-doctrine, should be strictly accurate in its *facts*, I would ask—in no unfriendly spirit—whether Mr. Grant Allen and Mr. Wallace have fully informed themselves upon each of the several positions taken in the paragraph cited with approval by Mr. Wallace (in the last number of NATURE, p. 381) from Mr. Grant Allen's "Vignettes," referring to the dimensions of the largest animals now existing, as compared with those of the faunæ of past epochs.

1. It is asserted that "no known extinct animal was as large as some of our modern Whales." When, some thirty years ago, I visited the so-called "coprolite" pits in the Suffolk crag, I was astonished at the multitude of the ivory-like "ear-bones" of whales found in a certain group of them; which were described by Prof. Owen, and compared with those of existing *Balænidæ*, in his "Fossil Mammals of Great Britain." From the fragments of gigantic ribs and vertebræ which I then saw at Felixstowe, I should certainly suppose the extinct whales they represent (which Prof. Owen regards as of Eocene age) to have been fully as large as those of the present time.

I would ask, further, whether sufficient account has been taken, in the statement just cited, of the most gigantic types of *Reptilian* Mesozoic life? Any one who has placed himself by the side of the huge bones of the *Cetiosaurus* which form such a conspicuous feature in the Oxford Museum, must, I think, be disposed to regard the animal there represented as having probably at least equalled the whale in *bulk*, though very likely not in length. And even this colossal reptile must have been far exceeded in dimensions by the *Atlantosaurus montanus* described by Prof. Marsh from the Wealden of Colorado. I would respectfully ask the authors, therefore, whether they are prepared to show that such an estimate is fallacious.

2. Having been led to believe, by all I have seen, heard, and read, that the *ordinary* bulk of our existing Elephants (I do not speak of exceptional "Jumboes") was considerably exceeded by that of the Mammoth and Mastodon—the former surpassing them in *height* (see the comparative measurements given by Prof. Owen, *op. cit.*), and the latter in *length* of body, I cannot but feel surprised that Mr. Grant Allen should speak of elephants "as having been increasing in size from the earliest epoch of their appearance to the present day"; still more, that Mr. Wallace should endorse the statement. Of course I shall at once bow to the superior knowledge of the latter most distinguished zoologist, when he refers me to trustworthy measurements in support of his position.

3. I can speak with more confidence in regard to the relative size of extinct Sharks, none of which, in the judgment of Mr. Grant Allen and Mr. Wallace, surpassed the forty-feet sharks of the present time. For I have now before me a tooth of a fossil shark (found in one of the before-mentioned "coprolite pits") of pretty regular triangular form, measuring *four* inches in length, *three* inches across the base, and seven-eighths of an inch in thickness between its flat surface and the most protuberant part of its convex surface; and I have seen others much larger, the length of some being said to range to *six* inches. Now when I brought this tooth home, I took an early opportunity of comparing it with the largest teeth of existing sharks that I could find in the British and Hunterian Museums, and found these to be pigmies by comparison. Unless, therefore, I can be referred to some fresh source of information, I must continue to believe (*pace* Mr. Grant Allen and Mr. Wallace) that some of the older sharks were far larger than any of which we have any knowledge at present.

4. Is it clear that *Tridacna* is the largest known Mollusk? I should have thought it exceeded by the gigantic *Ammonitidæ*, the largest specimens of which are not always to be found in museums; for I have seen one at Redcar (whose diameter I am afraid to state from memory, for fear of exaggeration) so massive that no one had undertaken the task of removing it.

5. No mention is made of *Crustacea*, though I should have thought that important class worthy of notice. I would ask where any existing crustacean types are to be found, that surpass in size the gigantic *Eurypteridæ* or even the largest *Trilobites*.

6. Of the *Foraminifera*, one of the most important classes in the whole animal kingdom for the share it has taken in the formation of our limestone rocks, I venture to speak with some special knowledge. The largest examples of this group known to us at the present time are the *Orbitolites* and *Cycloclypeus*. The former is a very widely diffused type, but only under peculiar local circumstances exceeds an inch in diameter, or one-tenth of an inch in thickness; the latter is (so far as I am yet aware) restricted to one locality, and, though attaining the large diameter of $2\frac{3}{4}$ inches, is scarcely thicker than an ordinary card. If these be compared with the massive *Nummulites* and *Orbitoides*, of which the vast *Nummulitic* limestones are composed, the advantage will be found clearly on the side of the latter.

But, in conclusion, I think it will be conceded that in estimating the general dimensions of a Fauna, we must take into account not merely the *size* of its largest animals, but *the range of their distribution*; and I would ask Mr. Wallace (whose knowledge of this subject no one appreciates more fully than myself) whether this consideration has been duly weighed by him. Our existing *colossal* land mammals (elephants, giraffes, rhinoceroses, and hippopotamuses) are limited to the tropical and sub-tropical regions of the Old World; while the great American continent is entirely destitute of them. Let this state of things be compared with the former extension of the Mastodon[1] and Mammoth through North America (which had for its own also the gigantic *Brontotheridæ*), as well as over Europe and Northern Asia; and the nearly equal range of the Rhinoceros and Hippopotamus (some species of all which seem to have lived contemporaneously during the Quaternary Period); whilst at the same time the wide area of South America was tenanted by another Mastodon, as well as by the colossal Sloths. There can be no reason to suppose again that the great Balænidæ were less abundant during the later Tertiary and Quaternary epochs, than they were either previously or subsequently. And if the evidence of the *abundance* of some of the colossal land-Mammals—afforded by the vast accumulation

[1] That the Mastodon, though it appeared much earlier than the Mammoth in the Old World, continued to exist in the New during the Quaternary period, is now, I believe, generally admitted. I myself, at the request of Dr. Warren, examined the contents of the well-preserved specimen obtained by him, and found therein twigs quite fresh enough for the microscopic recognition of their Coniferous structure; and Prof Asa Gray told me last summer that he could clearly identify them with a well-known existing type.

of Mammoth-tusks in the frozen mud of Siberia, and by the wonderful aggregation of Hippopotamus-bones revealed to us by Dr. Falconer's explorations in the Palermo caves—be also taken into account, we can scarcely, as it seems to me, avoid the conclusion, that the period in the later stages of which we get the first indubitable evidence of Man's existence (to say nothing of any anterior to it) was much more distinguished than the present for the aggregate bulk and wide distribution of the largest members of its fauna. WILLIAM B. CARPENTER

CAN Mr. Wallace throw any light on Mr. Allen's somewhat extraordinary sentence: "I feel a genuine respect for every donkey I meet, *when I remember that it was the mere accidental possession of an opposable thumb* that gave my ancestors a start over his in the race for the inheritance of the earth towards the very close of the tertiary period." I take Mr. Allen to be an evolutionist, but there is no place for accident in evolution, or in any other scientific theory. The "opposable thumb" must be the result of some conditioning factor, and this being so the word accident is quite out of place. ΦΠ

February 27

Moths Attracted by Falling Water

WHILST watching the great horse-shoe falls of the Skjálfandafljót near Ljósavatn in Iceland, I saw moth after moth fly deliberately into the falling water and disappear. Some which I noticed arriving from a distance, fluttered at first deviously, but as they neared the water flew straight in. The gleaming falls seemed at least as attractive as artificial light, and if the fact has not been observed in this country I should suppose it is because the moths likely to be attracted, fly by night, whilst in Northern Iceland there is no night during the summer. The preference trout show for pools near falls is more likely to arise from the extra food they find there, than the more aërated state of the water. The latter supposition, seeing the number of species of lake trout, always seemed to me a lame one, invented for want of a better, whilst the former explains why broken water is always inhabited by insectivorous fishes. The instinct of self-destruction in moths must be older than the introduction of artificial light, and cannot be of use exclusively to collectors, but though its benefits to salmon and trout are obvious enough, its advantages to the moths are not so apparent, unless this self-devotion checks an increase that otherwise would be disadvantageous. J. STARKIE GARDNER

Hypothetical High Tides

I HAVE no desire to constitute myself a champion of Mr. Ball's high tides, but I do not think that the testimony of the Coal-Measures, to which Mr. S. V. Wood calls attention, will decide much. These deposits are mainly of non marine origin, the plants being terrestrial, and the prevailing mollusc, *Anthracosia*, closely resembling *Unio*. Marine strata do indeed occur, but in almost inappreciable proportion. If it be objected that, in these marine episodes, the hypothetical tidal wave must have wrought fearful havoc; I would suggest that there is no proof that in the Carboniferous epoch the speed of the wave was enormously greater than at present. When we reflect that by that time nearly, if not quite all the classes of the animal kingdom had come into existence; we can hardly avoid the conclusion that the Coal-Measures were formed in a period which, in comparison with the age of the globe, must be regarded as comparatively recent. Considering how slight is the denuding power of modern tides, I doubt if even a treble velocity would materially increase the effect.

Mr. Elsden's suggestion that the accelerated tidal wave may account for the absence of estuarine deposits before the Carboniferous epoch, takes for granted what remains to be proved. How do we know that there were no pre-Carboniferous deltas? We recognise estuarine strata by the intermixture of terrestrial or fresh-water fossils with marine organisms. The Old Red Sandstone of Britain, being a lacustrine deposit, does not bear upon the question; but I see no reason why the Devonian strata of Russia, in which, according to Murchison, fresh-water fishes are associated with marine shells, may not be in part of estuarine origin. Below the Devonian, the evidence of terrestrial life is very meagre; and to infer from its absence in a set of beds that they must be marine, would be hazardous reasoning.

I do not make these observations in the interests of any theory, but simply to evoke discussion on a very interesting question.

Wellington, Salop, March 3 C. CALLAWAY

Rime Cloud observed in a Balloon

I SEE in NATURE, vol. xxv. p. 385, an interesting letter from a German physicist, who comments on the recital of my last balloon ascent (January 25, 1882) as published in your columns. I am very grateful for the numerous instances of *frost-rime* that he quotes as having been observed on former occasions, but I cannot possibly admit his theory of the liquidity of minute water-drops suspended in the air at a low temperature. The reason why I object to this view was explained more than a century ago by the celebrated Bouguer, when describing in 1744, to the French Academy of Sciences the coronæ he observed in the Andes on the occasion of his ascending the Pichincha. I beg leave to quote this interesting account of a quite forgotten exploration:—

"On voit presque tous les jours sur le sommet de ces montagnes un phénomène extraordinaire qui doit être aussi ancien que le monde, et dont il y a bien de l'apparence que personne n'est été temoin avant nous. Chacun de nous vit son ombre projetée sur un nuage qui n'était point à trente pas. Le peu de distance permettant de distinguer toutes les parties de l'ombre—on voyait le bras, les jambes, la tête; mais ce que nous étonne c'est que cette dérnière partie était ornée d'une gloire on d'une aureole formée de trois ou quatres petites couronnes concentriques d'une couleur tres vive, chacune avec le mieux nuance que l'arc-en-ciel primaire, c'est à dire le rouge en dehors.

After having insisted on the description of the phenomenon (*Mémoires de l'Académie* pour 1744, p. 264 and 265), Bouguer says:—"Le phénomène ne se trace que sur les nuages formés de gouttes de vapeur et même sur ceux dont les portraits sont glacées, mais non sur les gouttes de pluie comme l'arc-en-ciel." Having seen the *corona* for more than an hour, almost without interruption, and nothing resembling a rainbow, I cannot possibly admit any liquid water in the cloud, and I am obliged to oppose the surfusion theory as advocated by M. Jamin, to explain the crushing by ice-crystals of the loftiest trees of the Forest de Fontainebleau. W. DE FONVIELLE

Paris, February 26

The Markings on Jupiter

MR. DENNING's interesting communications in NATURE (vol. xxv. pp. 223, 265) led me to consult my notes of observations of Jupiter made in the summer of 1878. I used a telescope of only $3\frac{8}{8}$ inches aperture, but of exquisite definition, made by John Byrne, of New York. Under date of July 7, 1878, I find this entry:—"10 p.m.—There is a remarkable light spot near the centre of the light equatorial zone of Jupiter."

On July 27 I wrote:—"I saw on the bright equatorial belt of Jupiter a spot of obviously greater brightness than any other part of the disk. Just above and to the west of it was a dark spot on the southern belt. The bright spot grew more distinct as it approached the centre, and caught the eye the instant it was placed at the eyepiece. The bright spot was equal in diameter to about two-thirds of the width of the south belt."

Again on July 31:—"Saw a white spot on the light equatorial belt, probably the same seen on the 27th."

I have also sketches of Jupiter made in the fall of 1879, from which I see that on September 4, at 10 p.m., there was a distinct white spot indenting the northern border of the great south belt, and opposite the forward end of the red spot. On September 6 this white spot had advanced, so that it was ahead of the red spot. Other fainter white spots are shown in my sketches. These rude observations may be of some use in assisting Mr. Denning to trace back the history of the remarkable markings that for three or four years have attracted so much attention to Jupiter. G. P. SERVISS

New York, February 9

The Level of the Mediterranean

AMONG the "Notes" in NATURE, vol. xxv. p. 395, I read Prof. Naudin's opinion on the apparent lowering of the level of the Mediterranean along the whole Riviera during the months of January and February; but I think there is a far more simple explanation of the phenomenon. In Genoa we had for many days as much as 43 centimetres below the standard level, but that was

caused by the northerly winds that prevailed during the above-mentioned period, and which drove the water off the coast. Just now the lowering of the atmospheric pressure, that had been as high as 778 millimetres, gave a prevalence to southerly winds, and the sea reached again its former level.

L. LUIGGI,
Resident Engineer at the Pier Works, Genoa, Italy
February 28

A Strange Phenomenon

RELATIVE to the letter of Mr. James Moir, under the above title, which appeared recently in NATURE, I beg to observe that in the Highlands of Perthshire, some forty years ago, two men found themselves enveloped in flames, somewhat in the same style as Mr. Moir was on February 18 last. One Mr. John Stewart, who, for many years, drove the Mail gig between Dunkeld and Aberfeldy, told me that on a certain dark night, he and another man, climbing a rocky, heathery height in Rannock, were all at once set on flames by some mysterious fire, which appeared to proceed from the heather, which they were traversing, and the more they tried to rub the flames off the more tenaciously they seemed to adhere, and the more the fire increased in brightness and magnitude. Moreover, the long heather agitated by their feet, emitted streams of burning vapour, and for the space of a few minutes they were in the greatest consternation. They believed that they barely escaped a living cremation. Of course their liberal share of native superstition, along with the weird gloom of the night in the weird wilderness remote from human habitation, rendered their position the more alarming. Mr. Stewart did not mention whether the weather was stormy or not; but without doubt the object of their fear was St. Elmo's Fire. The ignis fatuus has been frequently seen in these Highland districts hovering over marshes, rivers, and churchyards, which was believed by the superstitious to be the ghosts of the dead. When the ignis fatuus was seen flickering over the graveyard, it was a sign—with them—that some one was to be buried there soon, and when seen floating over a river, it was a sign that some one was to be drowned there that night or soon after, the floating, wandering lights being their ghosts. Drainage, in this respect, has effected many changes. DONALD CAMERON

45, Calder Street, Govanhill, Glasgow, March 6

MR. JAMES MOIR, in last week's NATURE (p. 410), mentions a probable peculiar manifestation of St. Elmo's Fire, and asks if any one can give instances of a similar occurrence. About twenty years ago I was returning, during the evening, to my house from Great Yarmouth, a distance of three miles, and took the road of the Denes, intending to cross by the lower ferry. Before reaching it a dark cloud coming from the south-east, off the sea, suddenly surprised me, and drenched me with rain. I jumped into the boat, and when the boatman had pushed off, I remarked that every drop of rain hanging from my hair, beard, and clothes was luminous with white light, well seen, as it was very dark at the time. I found the same appearance had been observed by several pilots exposed to the same shower. I always attributed the occurrence to a species of St. Elmo's fire. It was mentioned at the time by a friend of mine at a scientific meeting in London, and thought curious. W. H. C. B.

Cheltenham, March 7

Parhelia

OF the parhelia of January 27 seen by M. Albert Riggerbach (NATURE, vol. xxv. p. 364) I was a spectator, and noted my observations at once. I was walking near Pavia when I observed the phenomenon about 3.45. A mock sun (one only) was in the same altitude with the sun on the horizon; M. Riggenbach's *faint cirrus* obviously corresponds to the *filamenti nebbiosi* in my note; they were as I well remember, with the mock sun in the eastern part of the sky, while in the opposite region some blackish *cumuli* approached slowly. FRANCIS PORRO

Pavia, Lombardy, February 27

Red Flints in the Chalk

ARE red flints common in the Chalk? A portion of our College farm lies on a gentle slope on the Upper Chalk, which rises westward from the banks of the Hampshire Avon. On the higher parts of this slope black flints are excessively abundant, so much so that after sheep have been folded on the land, the fields present the appearance of a newly macadamised road, and the flints are picked up and put into heaps until an opportunity offers to use them for road-metal; in the course of a year they "grow" again as thickly as before. But one field on a ridge near the foot of the slope is remarkable for the number of red flints it contains; on the dusty soil they look just like bits of broken earthenware, and might at first fail to attract attention. Their size is much less than the average size of the black flints; some are rounded and some angular, others almost flake like. As to the frequency of their occurrence, I found I was able to pick up at least one at every step I took. W. FREAM

College of Agriculture, near Downton, Salisbury,
February 28

THE SALMON DISEASE[1]

FOR some years an epidemic disease, followed by a very large number of deaths, has been observed to prevail among the salmon of certain Scottish and British rivers, from the Tay, on the north, as far as the Conway on the south.

The first obvious symptom of the malady is the appearance of one or more whitish patches upon the skin of parts of the body which are not covered with scales, such as the top and sides of the head, the adipose fin, and the soft skin at the bases of the other fins.

Such a patch, when it first attracts attention, may be as big as a sixpence. It is nearly circular, with a well-defined margin and a somewhat raised softer centre, from which faint ridges radiate towards the circumference. It is important to observe that a single small patch of this kind may be seen on the skin of a fish which, in all other respects, is perfectly healthy, and when there is no indication that the skin has ever been bruised or abraded in the place occupied by the patch. The patch, once formed, rapidly increases in size, and becomes confluent with any other patches which may have appeared in its neighbourhood. The marginal area, as it extends over the adjacent healthy skin, retains its character; but the central part undergoes an important change. It takes on the consistency of wet paper, and can be lifted up in soft flakes, as if it were a slough, from the surface of the derma or true skin, which it covers. In fact, it is obvious that this papyraceous substance has taken the place of the epidermis, so that the sensitive and vascular true skin is deprived of its natural protection. As the patch spreads, the true skin beneath the central papyraceous slough ulcerates and an open bleeding sore is formed, which may extend down to the bone, while it passes outwards into burrowing sinuses.

When the disease has reached this stage it obviously causes great irritation. The fish dash about and rub themselves against stones, and thus in all probability aggravate the evils under which they suffer. One vast open sore may cover the top of the head from the snout to the nape, and may extend over the gill covers. The edges of the fins become ragged; and, sometimes, the skin which invests them is so completely frayed away that the fin-rays stand out separately.

Although the affection of the skin appears, usually, if not invariably, to commence in the scaleless parts of the body, it does not stop there, but gradually spreads over the whole of the back and sides of the fish, though I have not yet seen a specimen in which it covered the whole ventral surface. The disease extends into the mouth, especially affecting the delicate valvular membrane attached to the inner sides of the upper and the lower jaws. It is said to attack the gills, but there has been no sign of it on these organs in any fish which I have had the opportunity of examining.

Fish which succumb to the disease become weak and

[1] A Contribution to the Pathology of the Epidemic known as the "Salmon Disease." Paper read at the Royal Society, March 2, by Prof. T. H. Huxley, LL.D., F.R.S.

sluggish, seeking the shallows near the banks of the river, where they finally die.

The flesh of a salmon affected by this disease presents no difference in texture or colour from that of a healthy fish; and those who have made the experiment declare that the flavour is just as good in the former case as in the latter. So far as my observations have gone the viscera may be perfectly healthy in the most extensively diseased fish; and there is no abnormal appearance in the blood.

It is known that a disease similar to that described is occasionally prevalent among salmon in North America and in Siberia; and I do not see any ground for the supposition that it is a novelty in British rivers. But public attention was first directed to it in consequence of its ravages in the Solway district a few years ago; and, in 1878, a Commission was appointed to inquire into the subject.

The evidence taken by the Commissioners leaves no room for doubt that the malady is to be assigned to the large and constantly increasing class of diseases which are caused by parasitic organisms. It is a contagious and infectious disease of the same order as ringworm in the human subject, mascardine among silkworms, or the potato disease among plants; and, like them, is the work of a minute fungus. In fact, the *Saprolegnia* which is the cause of the salmon disease is an organism in all respects very closely allied to the *Peronospora*, which is the cause of the potato disease.

It is a very curious circumstance, however, that while the *Peronosporæ* are always parasites—that is to say, depend altogether upon living plants for their support—the *Saprolegniæ* are essentially saprophytes; that is to say, they ordinarily derive their nourishment from dead animal and vegetable matters, and are only occasionally parasites upon living organisms. In this respect they resemble the *Bacteria*, if the results of recent researches, which tend to show that pathogenic bacteria are mere modifications of saprogenic forms, are to be accepted.

As I have said, I do not think that the evidence laid before the Commission of 1878 can leave any doubt as to the causation of the salmon disease on the minds of those who are acquainted with the history of the analogous diseases in other animals and in plants. Nevertheless, this evidence, valuable as it is, suggests more questions than it answers, and in November, 1881, hearing that the disease had broken out in the Conway, I addressed myself to the attempt to answer some of these.

It was already known that when the papyraceous slough-like substance which coats the skin of a diseased salmon is subjected to microscopic examination, it is found to be a *mycelium*, or fungus-turf, composed of a felt-work of fine tubular filaments or *hyphæ*, many of which are terminated by elongated oval enlargements, or *zoosporangia*. Within these the protoplasm breaks up into numerous spheroidal particles, each less than 1-2000th of an inch in diameter. These, the *zoospores*, are set free through an opening formed at the apex of the zoosporangium, and become actively or passively dispersed through the surrounding water. Herein lies the source of the contagiousness or infectiousness of the disease. For any one of these zoospores, reaching a part of the healthy skin of the same or of another salmon, germinates and soon gives rise to a mycelium similar to that from which it started.

But I could find no satisfactory information as to the manner in which the fungus enters the skin, how far it penetrates, the exact nature of the mischief which it does, or what ultimately becomes of it; nor was the identity of the pathogenic *Saprolegnia* of the salmon with that of any known form of saprogenic *Saprolegnia* demonstrated. It appeared to me, however, to be useless to attempt to deal with the disease until some of these important elements of the question were determined.

To this end, in the first place, I made a careful examination of the minute structure of both the healthy and diseased skin, properly hardened and cut into thin sections; and, in the second place, I tried some experiments on the transplantation of the *Saprolegnia* of the living salmon to dead animal bodies. Perhaps it will conduce to intelligibility if I narrate the results of the latter observations first.

The body of a recently killed common house-fly was gently rubbed two or three times over the surface of a patch of the diseased skin of a salmon, and was then placed in a vessel of water, on the surface of which it floated, in consequence of the large quantity of air which a fly's body contains. In the course of forty-eight hours, or thereabouts, innumerable white cottony filaments made their appearance, set close side by side, and radiated from the body of the fly in all directions. As these filaments had approximately the same length, the fly's body thus became inclosed in a thick white spheroidal shroud, having a diameter of as much as half an inch. As the filaments are specifically heavier than water, they gradually overcome the buoyancy of the air contained in the tracheæ of the fly, and the whole mass sinks to the bottom of the vessel. The filaments are very short when they are first discernible, and usually make their appearance where the integument of the fly is softest, as between the head and thorax, upon the proboscis, and between the rings of the abdomen. These filaments, in their size, their structure, and the manner in which they give rise to zoosporangia and zoospores are precisely similar to the hyphæ of the salmon fungus; and the characters of the one, as of the other, prove that the fungus is a *Saprolegnia* and not an *Achlya*. Moreover, it is easy to obtain evidence that the body of the fly has become infected by spores swept off by its surface when it was rubbed over the diseased salmon skin. These spores have in fact germinated, and their hyphæ have perforated the cuticle of the fly, notwithstanding its comparative density, and have then ramified outwards and inwards, growing at the expense of the nourishment supplied by the tissues of the fly.

This experiment, which has been repeated with all needful checks, proves that the pathogenic *Saprolegnia* of the living salmon may become an ordinary saprogenic *Saprolegnia*; and, *per contra*, that the latter may give rise to the former; and they lead to the important practical conclusion that the cause of salmon disease may exist in all waters in which dead insects, infested with *Saprolegniæ*, are met with; that is to say, probably in all the fresh waters of these islands, at one time or another.

On the other hand, *Saprolegnia* has never been observed on decaying bodies in salt water, and there is every reason to believe that, as a saprophyte, it is confined to fresh waters.[1]

Thus it becomes, to say the least, a highly probable conclusion that we must look for the origin of the disease to the *Saprolegniæ* which infest dead organic bodies in our fresh waters. Neither pollution, drought, nor overstocking will produce the disease if the *Saprolegnia* is absent. The most these conditions can do is to favour the development or the diffusion of the *materies morbi* where the *Saprolegnia* already exists.

Having infected dead flies with the salmon *Saprolegnia*, once from Conway and once from Tweed fish, I was enabled to propagate it from these flies to other flies, and, in this manner, to set up a sort of garden of *Saprolegniæ*. And having got thus far, I fancied it would be an easy task to determine the exact species of the *Saprolegnia* with which I was dealing, from the abundant data furnished by the works of Pringsheim, De Barry, and others,

[1] So far as I know there is only one case on record of the appearance of a fungus on a fish in salt water, and in this case it is not certain that the fungus was a *Saprolegnia*.

who have so fully studied these plants when cultivated on the same materials. For this purpose, it was necessary to obtain the oosporangia; and in ordinary course, these should have made their appearance on my *Saprolegniæ* in five or six days. Unfortunately, in the course of cultivation continued over two months, nothing of the kind has taken place. Zoosporangia have abounded in the ordinary form and also in that known as "dictyosporangia," but, in no instance, have any oosporangia appeared. After a few days of vigorous growth, the zoosporangia become scanty, and the fungus takes on a torulose form, segments of the hyphæ becoming swollen and then detached as independent "gemmæ," which may germinate. Sometimes the gemmæ are spheroidal and terminal, and closely simulate oosporangia.

Although, therefore, I have very little doubt that the *Saprolegnia* of the salmon is one of the forms of the "*S. ferax* group" of Pringsheim and De Bary, I have, at present, no proof of the fact.

Another very curious and unexpected peculiarity of the salmon *Saprolegnia*, both on the fish and when transmitted to flies, so far as my observations have hitherto gone, is that locomotive ciliated zoospores do not occur. I once saw one which exhibited a very slight motion for a few minutes after it left the zoosporangium; but although thousands must have passed under my notice, with the exception to which I have referred, they have always been perfectly quiescent and not unfrequently in different stages of germination. Whether the season of the year, or the conditions under which my saprolegnised flies were placed, have anything to do with the non-appearance of oosporangia and of locomotive zoospores in them I cannot say. But it is certain that the *Saprolegnia ferax* which commonly appears upon dead flies and other insects normally develops both oosporangia and locomotive zoospores in abundance.

From such notices by other observers as I can gather, oosporangia appear to be of very rare occurrence in the *Saprolegnia* of the salmon itself. Mr. Stirling mentions that he has met with them only four times. With respect to locomotive zoospores, I can find no positive evidence that they have been regularly, or even frequently, observed in the salmon *Saprolegnia*. But these points require careful investigation on freshly taken diseased fish.

Whether the zoospores are actively locomotive or not, they are quite free when they emerge from the zoosporangia; and, from their extreme minuteness, they must be readily carried away and diffused through the surrounding water. Hence, a salmon entering a stream inhabited by the *Saprolegnia* will be exposed to the chance of coming into contact with *Saprolegnia* spores; and the probability of infection, other things being alike, will be in proportion to the quantity of the growing *Saprolegnia*, and the vigour with which the process of spore-formation is carried on. At a very moderate estimate, a single fly may bear 1,000 fruiting hyphæ; and if each sporangium contains twenty zoospores, and runs through the whole course of its development in twelve hours, the result will be the production of 40,000 zoospores in a day, which is more than enough to furnish one zoospore to the cubic inch of twenty cubic feet of water. Even if we halve this rate of production, it is easy to see that the *Saprolegnia* on a single fly might furnish spores enough to render such a small shallow stream as salmon often ascend for spawning purposes, dangerous for several days. But a large fully diseased salmon may have as much as two square feet of its skin thickly covered with *Saprolegnia*. If we allow only 1,000 fruiting hyphæ for every square inch, we shall have 288,000 for the whole surface, which, at the same rate as before, gives over 10,000,000 spores for a day's production, or enough to provide a spore to every cubic foot of a mass of water 100 feet wide and five feet deep and four miles long. Forty such diseased salmon might furnish one spore to the gallon for all the water of the Thames (380,000,000 gallons per diem) which flows over Tedington Weir. But two thousand diseased salmon have been taken out of a single comparatively insignificant river in the course of a season.

It will be understood that the above numerical estimate of the productivity of *Saprolegnia*, has been adopted merely for the sake of illustration; that I do not intend to suggest that the zoospores are evenly distributed through the water into which they are discharged by the zoosporangia; and that allowance must be made for the very short life of those zoospores which do not speedily reach an appropriate nidus. Nevertheless, the conclusion remains arithmetically certain that every diseased salmon adds immensely to the chances of infection of those which are not diseased; and thus, the policy of extirpating every diseased fish as soon as possible, has ample justification. But, in practice, the attempt to stamp out the disease in this fashion would be so costly that it may be a question whether it is not better to put up with the loss caused by the malady.

There are many practical difficulties in the way of directly observing the manner in which the zoospores effect their entrance into the skin of the fish; but, on comparing the structure of the healthy integument with that of the diseased patches, the manner of the operation can readily be divined. The skin of the head of a salmon, for example, presents a thin superficial cellular epidermis covering the deep fibrous and vascular derma. The epidermic cells are distinguishable, as in fishes in general, into a deep, a middle, and a superficial layer. In the first, the cells are vertically elongated, in the second more rounded and polygonal, in the third flattened. Many of the cells of the middle layer are of the nature of "mucous cells." They enlarge and become filled with a mucous secretion; and, rising to the surface, burst and discharge their contents, which give rise to the mucous fluid with which the fish's body is covered. The openings of these "mucous cells" remain patent for some time and are to be seen in thin vertical sections. The hyphæ of the spores which attach themselves to the fish may enter by these openings, but even if they do not, the flattened superficial cells certainly offer no greater resistance than does the tough cuticle of a fly. However this may be, sections of young patches of diseased skin show that the hyphæ of the fungus not only traverse the epidermis, but bore through the superficial layer of the derma for a distance, in some cases, of as much as one-tenth of an inch. Each hypha thus comes to have a stem-part, which lies in the epidermis, and a root-part, which lies in the derma. Each of these elongates and branches out. The free ends of the stem-hyphæ rise above the surface of the epidermis and become converted into zoosporangia, more or fewer of the spores of which attach themselves to the surrounding epidermis and repeat the process of penetration. Thus the epidermis and the derma become traversed by numerous hyphæ set close side by side. But, at the same time, these hyphæ send off lateral branches which spread radially, forcing asunder the middle and deeper layers of the epidermic cells, and giving rise to the radiating ridges which are visible to the naked eye in the peripheral part of the patch. The force of the growth of the hyphæ which traverse the epidermis, is made obvious by the curious manner in which, when the central tract of a patch is teased out, the distorted epidermis cells are seen adhering to it as if they were spitted upon it.

In the derma, the root-hyphæ branch out, pierce the bundles of connective tissue, and usually end in curiously distorted extremities.

The effect of the growth of the stem-hyphæ is to destroy the epidermis altogether. Its place is taken by a thick, felted, mycelium, which entangles the minute particles of sand which are suspended in the water, and thus no doubt

constitutes a very irritating application to the sensitive surface of the true skin.

In the true skin, the tracks of the root-hyphæ are not accompanied by any obvious signs of inflammation, but the hyphæ are so close set, that they cannot fail to interfere with the nutrition of the part, and thus bring about necrosis and sloughing. Such sloughing in fact gradually takes place, small vessels give way and bleed, and the burrowing sore, which is characteristic of the advanced stages of the disease is produced.

The skin of the head may thus be eaten away down to the bone and gristle of the skull, but I have not observed the fungus to enter these. On the scaly part of the skin, the fungus burrows in the superficial and in the deep layer of the pouches of the scales, but I have not observed the scales themselves to be perforated.

When I found that the fungus penetrated the true skin, and thus gained access to the lymphatic spaces and blood-vessels, it became a matter of great interest to ascertain whether the hyphæ might not break up into turuloid segments (as in the case of the *Empusa muscæ*), and thus give rise to general septic poisoning, or fungoid metastastis. However, I have never been able to find any indication of the occurrence of such a process.

But a very important practical question arises out of the discovery that the fungus penetrates into the derma. There is much reason to believe, that if a diseased salmon returns to salt water, all the fungus which is reached by the saline fluid is killed, and the destroyed epidermis is repaired. But the sea water has no access to the hyphæ which have burrowed into the true skin; and hence it must be admitted to be possible, that, in a salmon which has become to all appearance healed in the sea, and which looks perfectly healthy when it ascends a river, the remains of the fungus in the derma may break out from within, and the fish become diseased without any fresh infection. It has not infrequently been observed, that salmon in their upward course became diseased at a surprisingly short distance from the sea, and it is possible that the explanation of the fact is to be sought in the revival of dormant *Saprolegnia*, rather than in new infection. It is to be hoped, that experiments, now being carried on at Berwick, will throw some light on this point, as well as upon the asserted efficacy of sea water in destroying the fungus which it reaches.

These are the chief results of this season's observations on the salmon disease. Incomplete as they are, they appear to me to justify the following conclusions:—

1. That the *Saprolegnia* attacks the healthy living salmon exactly in the same way as it attacks the dead insect, and that it is the sole cause of the disease, whatever circumstances may, in a secondary manner, assist its operations.

2. That death may result without any other organ than the skin being attacked, and that, under these circumstances, it is the consequence partly of the exhaustion of nervous energy by the incessant irritation of the felted mycelium with its charge of fine sand, and partly of the drain of nutriment appropriated by the fungus.

3. That the penetration of the hyphæ of the *Saprolegnia* into the derma renders it at least possible that the disease may break out in a fresh-run salmon without re-infection.

4. That the cause of the disease, the *Saprolegnia*, may flourish in any fresh water, in the absence of salmon, as a saprophyte upon dead insects and other animals.

5. That the chances of infection for a healthy fish entering a river, are prodigiously increased by the existence of diseased fish in that river, inasmuch as the bulk of *Saprolegnia* on a few diseased fish vastly exceeds that which would exist without them.

6. That as in the case of the potato disease, the careful extirpation of every diseased individual is the treatment theoretically indicated; though, in practice, it may not be worth while to adopt the treatment.

ON THE CONSERVATION OF SOLAR ENERGY[1]

THE question of the maintenance of Solar Energy is one that has been looked upon with deep interest by astronomers and physicists from the time of La Place downwards.

The amount of heat radiated from the sun has been approximately computed by the aid of the pyrheliometer of Pouillet and by the actinometers of Herschel and others at 18,000,000 of heat units from every square foot of its surface per hour, or, put popularly, as equal to the heat that would be produced by the perfect combustion every thirty-six hours of a mass of coal of specific gravity = 1·5 as great as that of our earth.

If the sun were surrounded by a solid sphere of a radius equal to the mean distance of the sun from the earth (95,000,000 of miles), the whole of this prodigious amount of heat would be intercepted; but considering that the earth's apparent diameter as seen from the sun is only seventeen seconds, the earth can intercept only the 2,250-millionth part. Assuming that the other planetary bodies swell the amount of intercepted heat by ten times this amount, there remains the important fact that $\frac{224999999}{225000000}$ of the solar energy is radiated into space, and apparently lost to the solar system, and only $\frac{1}{225000000}$ utilised.

Notwithstanding this enormous loss of heat, solar temperature has not diminished sensibly for centuries, if we neglect the periodic changes, apparently connected with the appearance of sun-spots that have been observed by Lockyer and others, and the question forces itself upon us how this great loss can be sustained without producing an observable diminution of solar temperature even within a human lifetime.

Amongst the ingenious hypotheses intended to account for a continuance of solar heat is that of shrinkage, or gradual reduction of the sun's volume suggested by Helmholtz. It may, however, be urged against this theory that the heat so produced would be liberated throughout its mass, and would have to be brought to the surface by conduction, aided perhaps by convection; but we know of no material of sufficient conductivity to transmit anything approaching the amount of heat lost by radiation.

Chemical action between the constituent parts of the sun has also been suggested; but here again we are met by the difficulty that the products of such combination would ere this have accumulated on the surface, and would have formed a barrier against further action.

These difficulties have led Sir Wm. Thomson, following up Mayer's speculation, to the suggestion that the cause of the maintenance of solar temperature might be found in the circumstance of meteorolites falling upon the sun from great distances in space, or with an acquired velocity due to such fall, and he shows that each pound of matter so imported would represent a large number of heat units depending upon the original distance. Yet the aggregate of material that would thus have to be incorporated with the sun would tend to disturb the planetary equilibrium, and must ere this have shortened our year to an extent exceeding that resulting from astronomical records and observation. In fact, Sir William Thomson soon abandoned the meteoric hypothesis for that of simple transfer of heat from the interior of a liquid sun to the surface by means of convection currents, which latter hypothesis appears at the present time to be supported by Prof. Stokes and other leading physicists of the day.

But if either of these hypotheses could be proved we should only have the satisfaction of knowing that the solar waste of energy by dissipation into space was not dependent entirely upon loss of its sensible heat, but that

[1] Paper read at the Royal Society, March 2, by C. William Siemens, D.C.L., LL.D., F.R.S., Mem. Inst. C.E.

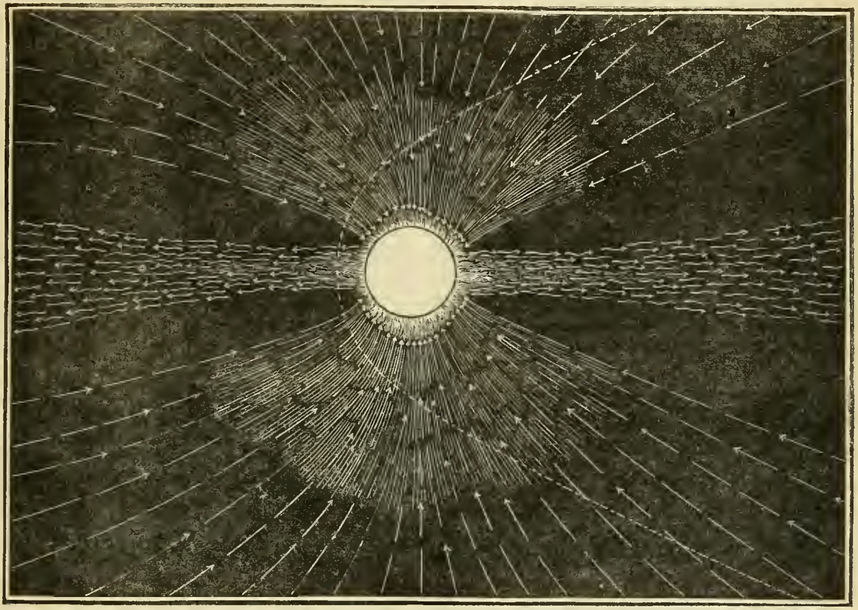
ts existence as a luminary would be prolonged by calling into requisition a limited, though may be large, store of energy in the form of separated matter. The true solution of the problem will be furnished by a theory, according to which the radiant energy which is now supposed to be dissipated into space and irrecoverably lost to our solar system, could be arrested and brought back in another form to the sun itself, there to continue the work of solar radiation.

Some years ago it occurred to me that such a solution of the solar problem might not lie beyond the bounds of possibility, and although I cannot claim intimate acquaintance with the intricacies of solar physics, I have watched its progress, and have engaged also in some physical experiments bearing upon the question, all of which have served to strengthen my confidence and ripened in me the determination to submit my views, not without some misgiving, to the touchstone of scientific criticism.

For the purposes of my theory, stellar space is supposed to be filled with highly rarefied gaseous bodies, including hydrogen, oxygen, nitrogen, carbon, and their compounds, besides solid materials in the form of dust. This being the case, each planetary body would attract to itself an atmosphere depending for its density upon its relative attractive importance, and it would not seem unreasonable to suppose that the heavier and less diffusible gases would form the staple of these atmospheres; that, in fact, they would consist mostly of nitrogen, oxygen, and carbonic anhydride, whilst hydrogen and its compounds would predominate in space.

But the planetary system, as a whole, would exercise an attractive influence upon the gaseous matter diffused through space, and would therefore be surrounded by an interplanetary atmosphere, holding an intermediate position between the planetary atmospheres and the extremely rarefied stellar space.

In support of this view it may be urged, that in following out the molecular theory of gases as laid down by



Clerk Maxwell, Clausius, and Thomson, it would be difficult to assign a limit to a gaseous atmosphere in space and, further, that some writers, among whom I will here mention only Grove, Humboldt, Zoellner and Mattieu Williams, have boldly asserted the existence of a space filled with matter, and that Newton himself, as Dr. Sterry Hunt tells us in an interesting paper which has only just reached me, has expressed views in favour of such an assumption. Further than this, we have the facts that meteorolites whose flight through stellar, or at all events through interplanetary space, is suddenly arrested by being brought into collision with our earth, are known to contain as much as six times their own volume of gases taken at atmospheric pressure; and Dr. Flight has only very recently communicated to the Royal Society the analysis of the occluded gases of one of these metorolites taken immediately after the descent to be as follows:—

CO_2	0·12
CO	31·88
H	45·79
CH_4	4·55
N	17·66
	100·00

It appears surprising that there was no aqueous vapour, considering there was much hydrogen and oxygen in combination with carbon, but perhaps the vapour escaped observation, or was expelled to a greater extent than the other gases by external heat when the meteorolite passed through our atmosphere. Opinions concur that the gases found occluded in meteorolites cannot be supposed to have entered into their composition during the very short period of traversing our atmosphere, but if any doubt should exist on this head, it ought to be set at rest by the fact that the gas principally occluded is hydrogen, which

is not contained in our atmosphere in any appreciable quantity.

Further proof of the fact that stellar space is filled with gaseous matter is furnished by spectrum analysis, and it appears from recent investigation, by Dr. Huggins and others, that the nucleus of a comet contains very much the same gases found occluded in meteorolites, including "carbon, hydrogen, nitrogen, and probably oxygen," whilst according to the views set forth by Dewar and Liveing it also contains nitrogenous compounds such as cyanogen.

Adversely to the assumption that interplanetary space is filled with gases, it is urged that the presence of ordinary matter would cause sensible retardation of planetary motion, such as must have made itself felt before this; but assuming that the matter filling space is an almost perfect fluid not limited by border surfaces, it can be shown on purely mechanical grounds, that the retardation by friction through such an attenuated medium would be very slight indeed, even at planetary velocities.

But it may be contended that, if the views here advocated regarding the distribution of gases were true, the sun should draw to itself the bulk of the least diffusible, and therefore the heaviest gases, such as carbonic anhydride, carbonic oxide, oxygen and nitrogen, whereas spectrum analysis has proved on the contrary a prevalence of hydrogen.

In explanation of this seeming anomaly, it can be shown in the first place, that the temperature of the sun is so high, that such compound gases as carbonic anhydride and carbonic oxide, could not exist within it, their point of dissociation being very much below the solar temperature; it has been contended, indeed, by Mr. Lockyer, that none of the metalloids have any existence at these temperatures, although, as regards oxygen, Dr. Draper asserts its existence in the solar photosphere; there must be regions, however, outside that thermal limit, where their existence would not be jeopardised by heat, and here great accumulation of these comparatively heavy gases that constitute our atmosphere would probably take place, were it not for a certain counterbalancing action.

I here approach a point of principal importance in my argument, upon the proof of which my further conclusions must depend.

The sun completes one revolution on its axis in 25 days, and its diameter being taken at 882,000 miles, it follows that the tangential velocity amounts to 1·25 miles per second, or to 4·41 times the tangential velocity of our earth. This high rotative velocity of the sun must cause an equatorial rise of the solar atmosphere to which Mairan, in 1731, attributed the appearance of zodiacal light. La Place rejected this explanation on the ground that the zodiacal light extended to a distance from the sun exceeding our own distance, whereas the equatorial rise of the solar atmosphere due to its rotation could not exceed 9-20ths of the distance of Mercury. But it must be remembered that La Place based his calculation upon the hypothesis of an empty stellar space (filled only with an imaginary ether), and that the result of solar rotation would be widely different, if it was supposed to take place within a medium of unbounded extension. In this case pressures would be balanced all round, and the sun would act mechanically upon the floating matter surrounding it in the manner of a fan, drawing it towards itself upon the solar surfaces, and projecting it outwards in a continuous disk-like steam.

By this fan action, hydrogen, hydrocarbons, and oxygen, are supposed to be drawn in enormous quantities toward the polar surfaces of the sun; during their gradual approach, they will pass from their condition of extreme attenuation and extreme cold, to that of compression, accompanied with rise of temperature, until on approaching the photosphere, they burst into flame, giving rise to a great development of heat, and a temperature commensurate with their point of dissociation at the solar density. The result of their combustion will be aqueous vapour and carbonic anhydride or oxide, according to the sufficiency or insufficiency of oxygen present to complete the combustion, and these products of combustion in yielding to the influence of centrifugal force will flow towards the solar equator, and be thence projected into space.

The next question for consideration is: What would become of these products of combustion when thus rendered back into space? Apparently they would gradually change the condition of stellar material, rendering it more and more neutral, but I venture to suggest the possibility, nay, the probability, that solar radiation would, under these circumstances, step in to bring back the combined materials to a condition of separation by a process of dissociation carried into effect at the expense of that solar energy which is now supposed to be lost to our planetary system.

According to the law of dissociation as developed by Bunsen and Sainte-Claire Deville, the point of dissociation of different compounds depends upon the temperature on the one hand, and upon the pressure on the other. According to Sainte-Claire Deville, the dissociation tension of aqueous vapour of atmospheric pressure and at 2800° C. is 0.5, or only half of the vapour can exist as such, its remaining half being found as a mechanical mixture of hydrogen and oxygen, but that with the pressure, the temperature of dissociation rises and falls, as the temrerature of saturated steam rises and falls with its pressure. It is therefore conceivable that the temperature of the solar photosphere may be raised by combustion to a temperature exceeding 2800° C., whereas dissociation may be effected in space at a lower temperature.

But these investigations had reference only to heats measured by means of pyrometers, but do not extend to the effects of radiant heat. Dr. Tyndall has shown by his exhaustive researches that vapour of water and other gaseous compounds intercept radiant heat in a most remarkable degree, and there is other evidence to show that radiant energy from a scource of high intensity possesses a dissociating power far surpassing the measurable temperature to which the compound substance under its influence is raised. Thus carbonic anhydride and water are dissociated in the leaf cells of plants, under the influence of the direct solar ray at ordinary summer temperature, and experiments in which I have been engaged for nearly three years[1] go to prove that this dissociating action is obtained also under the radiant influence of the electric arc, although it is scarcely perceptible if the source of radiant energy is such as can be produced by the combustion of oil or gas.

The point of dissociation of aqueous vapour and carbonic anhydride admits, however, of being determined by direct experiment. It engaged my attention some years ago, but I have hesitated to publish the qualitative results I then obtained, in the hope of attaining to quantitative proofs.

These experiments consisted in the employment of glass tubes, furnished with platinum electrodes, and filled with aqueous vapour or with carbonic anhydride in the usual manner, the latter being furnished with caustic soda to regulate the vapour pressure by heating. Upon immersing one end of the tube charged with aqueous vapour in a refrigerating mixture of ice and chloride of calcium, its temperature at that end was reduced to 32° C., corresponding to a vapour pressure, according to Regnault, of 1-1800 of an atmosphere. When so cooled no slow electric discharge took place on connecting the two electrodes with a small induction coil. I then exposed the

[1] See Proceedings, Roy. Soc. Vol. xxx. 1 Mar. 1880 and a paper read before Section A of the British Association 1 Sep. 1881 and ordered to be printed in the Report.

end of the tube projecting out of the freezing mixture, backed by white paper, to solar radiation (on a clear summer's day) for several hours, when upon again connecting up to the inductorium, a discharge, apparently that of a hydrogen vacuum, was obtained. This experiment being repeated furnished unmistakable evidence, I thought, that aqueous vapour had been dissociated by exposure to solar radiation. The CO_2 tubes gave, however, less reliable results. Not satisfied with these qualitative results, I made arrangements to collect the permanent gases so produced by means of a Sprengel pump, but was prevented by lack of time from pursuing the inquiry, which I purpose, however, to resume shortly, being of opinion that, independently of my present speculation, the experiments may prove useful in extending our knowledge regarding the laws of dissociation.

Assuming, for my present purpose, that dissociation of aqueous vapour was really effected in the experiment just described, and assuming, further, that stellar space is filled with aqueous and other vapour of a density not exceeding the 1-2000th part of our atmosphere, it seems reasonable to suppose that its dissociation would be effected by solar radiation, and that solar energy would thus be utilised. The presence of carbonic anhydride and carbonic oxide would only serve to facilitate the decomposition of the aqueous vapour by furnishing substances to combine with nascent oxygen and hydrogen. By means of the fan-like action resulting from the rotation of the sun, the vapour dissociated in space to-day would be drawn towards the polar surfaces of the sun to-morrow, be heated by increase in density, and would burst into flame at a point where both their density and temperature had reached the necessary elevation to induce combustion, each complete cycle taking, however, years to be accomplished. The resulting aqueous vapour, carbonic anhydride and carbonic oxide, would be drawn towards the equatorial regions, and be then again projected into space by centrifugal force.

Space would, according to these views, be filled with gaseous compounds in process of decomposition by solar radiant energy, and the existence of these gases would furnish an explanation of the solar absorption spectrum, in which the lines of some of the substances may be entirely neutralised and lost to observation. As regards the heavy metallic vapours revealed in the sun by the spectroscope, it is assumed that these form a lower and denser solar atmosphere, not participating in the fan-like action which is supposed to effect the light outer atmosphere only, in which hydrogen is the principal factor.

Such a dense metallic atmosphere could not participate in the fan action affecting the lighter photosphere, because this is only feasible on the supposition that the density of the in-flowing current is, at equal distances from the gravitating centre, equal or nearly equal to the outflowing current. It is true that the products of combustion of hydrogen and carbonic oxide are denser than their constituents, but this difference may be balanced by their superior temperature on leaving the sun, whereas the metallic vapours would be unbalanced, and would therefore obey the laws of gravitation, recalling them to the sun. On the surface of contact between the two solar atmospheres, intermixture induced by friction, must take place, however, giving rise perhaps to those vortices and explosive effects which are revealed to us by the telescope, and have been commented on by Sir John Herschel and other astronomers. Some of the denser vapours would probably get intermixed and carried away mechanically by the lighter gases, and give rise to that cosmic dust which is observed to fall upon our earth in not inappreciable quantities. Excessive intermixture would be prevented by the intermediary neutral atmosphere, the penumbra.

As the whole solar system moves through space at a pace estimated at 150,000,000 of miles annually (being about one-fourth of the velocity of the earth in its orbit), it appears possible that the condition of the gaseous fuel supplying the sun may vary according to its state of previous decomposition, in which other heavenly bodies may have taken part. May it not be owing to such differences in the quality of the fuel supplied that the observed variations of the solar heat may depend? and may it not be in consequence of such changes in the thermal condition of the photosphere that sun-spots are formed?

The views here advocated could not be thought acceptable unless they furnished at any rate a consistent explanation of the still somewhat mysterious phenomena of the zodiacal light and of comets. Regarding the former, we should be able to return to Mairan's views, the objection by La Place being met by a continuous outward flow from the solar equator. Luminosity would be attributable to particles of dust emitting light reflected from the sun, or by phosphorescence. But there is another cause for luminosity of these particles, which may deserve a passing consideration. Each particle would be electrified by gaseous friction in its acceleration, and its electric tension would be vastly increased in its forcible removal, in the same way as the fine dust of the desert has been observed by Werner Siemens to be in a state of high electrification on the apex of the Cheops Pyramid. Would not the zodiacal light also find explanation by slow electric discharge backward from the dust towards the sun? and would the same cause not account for a great difference of potential between the sun and earth, which latter may be supposed to be washed by the solar radial current? May not the presence of the current also furnish us with an explanation of the fact that hydrogen, while abounding apparently in space, is practically absent in our atmosphere, where aqueous vapour, which may be partly derived from the sun, takes its place? An action analogous to this, though on a much smaller scale, may be set up also by terrestrial rotation giving rise to an electrical discharge from the outgoing equatorial stream to the polar regions, where the atmosphere to be pierced by the return flood is of least resistance.

It is also important to show how the phenomena of comets could be harmonised with the views here advocated, and I venture to hope that these occasional visitors will serve to furnish us with positive evidence in my favour. Astronomical physicists tell us that the nucleus of a comet consists of an aggregation of stones similar to meteoric stones. Adopting this view, and assuming that the stones have absorbed in stellar space gases to the amount of six times their volume, taken at atmospheric pressure, what, it may be asked, will be the effect of such a mass of stone advancing towards the sun at a velocity reaching in perihelion the prodigious rate of 366 miles per second (as observed in the comet of 1845), being twenty-three times our orbital rate of motion? It appears evident that the entry of such a divided mass into a comparatively dense atmosphere must be accompanied by a rise of temperature by frictional resistance, aided by attractive condensation. At a certain point the increase of temperature must cause ignition, and the heat thus produced must drive out the occluded gases, which in an atmosphere 3000 times less dense than that of our earth would produce $6 \times 3000 = 18,000$ times the volume of the stones themselves. These gases would issue forth in all directions, but would remain unobserved except in that of motion, in which they would meet the interplanetary atmosphere with the compound velocity and form a zone of intense combustion, such as Dr. Huggins has lately observed to surround the one side of nucleus, evidently the side of forward motion. The nucleus would thus emit original light, whereas the tail may be supposed to consist of stellar dust rendered luminous by reflex action produced by the light of the sun and comet combined, as foreshadowed already by Tyndall, Tate, and others, starting each from different assumptions.

These are in brief the outlines of my reflections regard-

ing this most fascinating question, which I venture to put before the Royal Society. Although I cannot pretend to an intimate acquaintance with the more intricate phenomena of solar physics, I have long had a conviction derived principally from familiarity with some of the terrestrial effects of heat, that the prodigious and seemingly wanton dissipation of solar heat is unnecessary to satisfy accepted principles regarding the conservation of energy, but that it may be arrested and returned over and over again to the sun, in a manner somewhat analogous to the action of the heat recuperator in the regenerative gas furnace. The fundamental conditions are:—

1. That aqueous vapour and carbon compounds are present in stellar or interplanetary space.

2. That these gaseous compounds are capable of being dissociated by radiant solar energy while in a state of extreme attenuation.

3. That these dissociated vapours are capable of being compressed into the solar photosphere by a process of interchange with an equal amount of reassociated vapours, this interchange being effected by the centrifugal action of the sun itself.

If these conditions could be substantiated, we should gain the satisfaction that our solar system would no longer impress us with the idea of prodigious waste through dissipation of energy into space, but rather with that of well-ordered self-sustaining action, capable of perpetuating solar radiation to the remotest future.

FURTHER OBSERVATIONS ON THE FRESH-WATER MEDUSA, MADE DURING THE SUMMER, 1881

1. THE Freshwater Medusa—*Limnocodium Sowerbii*—reappeared in the lily-house tank in the Botanical Gardens, Regent's Park, during the summer of 1881, as the readers of NATURE were duly informed.

In spite of the renewed opportunities for study thus afforded, the life-history of this interesting organism still remains a mystery, and it is still exceedingly difficult to frame any hypothesis as to the original introduction of the jelly-fish into the tank where it was discovered by Mr. Sowerby in 1880.

The only general hypothesis which can be entertained as to the original introduction of the jelly-fish, is that it came "in some way at some time" with plants deposited in the tank.

It is *improbable* that the jelly-fish can have existed for many seasons in the tank unobserved, though *possible*, supposing that it first appeared in small numbers.

The last importation of an aquatic plant into the lily-house in Regent's Park, previous to the discovery of the jelly-fish in June, 1880, is that to which suspicion naturally attaches itself. This importation occurred early in March, 1879, when, as Mr. Sowerby kindly informs me, a Miss Tupper, whose address is not in his possession, presented to the Royal Botanical Society a specimen of a species of *Pontederia*. This specimen was wrapped in a piece of brown paper, was about one foot long, was crushed and as dry as hay, in fact the Garden superintendent and the man in charge of the tank thought it dead. The specimen is believed to have come from Brazil. It vegetated after being placed in the tank, and has given rise to a copious growth, part of which is now in the lily-house of the Botanic Garden at Oxford.

Mr. Sowerby cannot remember the introduction of any new plants into the tank at such time previous to this as would render it probable that the jelly-fish were introduced on such previous occasions.

It is clear, then, that if the jelly-fish were introduced with the *Pontederia*, either the animal itself or its eggs must have great power of resistance to partial desiccation. Of this power of resistance we have no further evidence, for the tank in the Lily-house is not completely emptied and dried in the winter, though the water is run off, a deep trough of water and mud remains permanently at one end of the tank.

At the same time it is in accordance with what is known as to many lacustrine animals that the eggs or young stages of the fresh-water jelly-fish should be able to resist partial desiccation. Hence the theory of its introduction with the *Pontederia* is, though far from demonstrated, yet quite tenable. Plants of this *Pontederia* were sent from Regent's Park to Kew and Oxford (where they are flourishing) some months before the discovery of the jelly-fish in June, 1880. But no jelly-fish made their appearance in consequence (so far as is known) in the tanks at Kew and Oxford. Hence the association with the *Pontederia* of the eggs or young of the jelly-fish cannot have been a very intimate one.

2. The history of the jelly-fish in the Regent's Park tank is as follows:—It was first seen by Mr. Sowerby on June 10, 1880. At that time there were some specimens nearly full-grown and a vast number of very young ones (apparently recently hatched) also. By the end of July not a specimen could be found in the tank. All the mature specimens examined by me in 1880 were males, numbering 150. I entirely failed to obtain any specimen which was female, either young or mature. Nevertheless Mr. Sowerby was of opinion that young were produced by adult individuals isolated and kept by him in a small glass jar. These young were those which I reported on in the *Quart. Journ. Micr. Sci.*, January, 1881. I could find only adult males in the jar with them, and think that it is possible (though not certain) that the young were hatched from eggs floating in the water when first introduced into the jar. They would thus be only *late-hatching* members of the same brood of which adults were discovered on June 10. It is, on the other hand, possible that they belonged to a second generation.

The males observed in 1880 discharged abundant motile spermatozoa from their genital sacs and were obviously ready for procreation.

Thus in 1880 we were left in ignorance of the female of *Limnocodium*, and in nearly complete ignorance as to the period and mode of reproduction.

3. In 1881 Mr. Sowerby observed the Medusæ again, only two days after the anniversary of their first appearance, namely, on June 16. He states, in a letter kindly written for me, that only a "few were seen, although the water appeared swarming with minute individuals just large enough to be distinctly seen with the naked eye. Many of these we determined by examination with a glass; they did not, however, appear to come to manhood, and about the 25th of June the whole of the Medusæ vanished."

It is obvious that some process of reproduction had taken place between June, 1880, and June, 1881, giving rise to the Medusæ observed in 1881. Where were the females which produced the eggs from which this new generation was born? As in 1880, so in 1881, when first observed in June, *both minute young apparently just hatched*, and also *full-grown individuals were simultaneously detected*. In 1881 I examined about fifty of the full-grown individuals from the Regent's Park: as in 1880 they were all males. It seems probable that the adults observed on June 10 were merely early-hatched members of the same brood as the young (of various ages and sizes) which abounded with them.

From the experience of these two years it appears probable that the first specimens which hatch out must do so six weeks or two months before the middle of June. But as to the character of the eggs from which they hatch, we have as yet no idea. It would seem likely that those eggs were deposited before the emptying of the tank in December, and probably enough in the summer before the dying down of the males, so abundant until their total disappearance at the end of July.

But since the females have never been seen, it is possible that they have a slightly different form and habit from that of the males, or possibly a *very* different form—perhaps hydroid! In either case the females may have existed in the deeper parts of the tank either floating or attached, and so have escaped observation, whilst the high-swimming males were taken in abundance. The eggs may have been fertilised in August by the dying males, and have proceeded to a certain stage of development in the autumn—being then normally arrested in development in the winter (the period corresponding to the emptying of the tank and to a period of drought in their natural condition), as in the case of *Hydra viridis*. Then they would be ready to enter upon a new period of development and growth in the following spring and early summer.

4. The above suggestion is eminently hypothetical, and is somewhat difficult to reconcile with the result of the interesting experiment carried out at the suggestion of Mr. George Busk, F.R.S., in consequence of which some of the Medusæ were transferred in 1881 from the Regent's Park to the Victoria tank, in No. 10 house, at the Royal Gardens, Kew. This transfer was effected on June 16, four days after the second appearance of the Medusæ at Regent's Park. It is important to notice (as I am informed by Mr. Sowerby) that only six or eight full-grown Medusæ were so transferred—and I cannot feel much doubt that these were all males—similar to all those which I have examined. But with these half-dozen full-grown specimens, a quart of water containing many hundreds of very minute Medusæ was also taken. The flask of water and the little and big Medusæ were poured out into the large tank at Kew on the same day—June 16.

Nothing was seen of them at Kew until *more than two months afterwards*, when (on August 18) the whole tank was seen to be swarming with full-grown *Limnocodium*.

The question which arises is: Were these Medusæ simply the young Medusæ which had been transferred, now grown to maturity; or were they a new generation?

The chief objection to the view that the Medusæ swarming at Kew in August were the same Medusæ which were transferred in the young state from Regent's Park two months before, is found in the fact of their extraordinary abundance. I removed and examined myself at the end of September, from the tank at Kew, 200 specimens. Other naturalists also obtained numerous specimens. In the meantime, be it remembered, the whole colony had *died down or disappeared* (as early as June 25) *from the original tank in the Regent's Park!*

I am inclined to the view that the Kew Medusæ were actually the same specimens as those transferred in the young state, which were placed in more favourable conditions at Kew than their fellows experienced in the Regent's Park. The tank at Kew is larger than that in Regent's Park, food is therefore more abundant, and moreover the temperature was, when I observed it, from six to ten degrees Fahrenheit lower in the tank at the former than in that at the latter locality (75°–80° Kew, as against 85°–90° Regent's Park).

A fact which is strongly against the supposition that the transferred Medusæ had reproduced themselves is that the half-dozen mature specimens transferred were almost certainly males, and that the young specimens had not more than time to grow to full size, and were not observed to have arrived at maturity in the interval.

I made renewed and careful examination of the Medusæ at Kew at the end of September and in the beginning of October, when I had the advantage, through the kindness of Sir Joseph Hooker, of making use of the admirable laboratory recently erected in the Gardens. The specimens were often appreciably larger than any I had previously obtained from Regent's Park (fully half an inch across the expanded disc). All the specimens examined (200 in number) proved to be males. At the end of September there were no young or very small specimens in the Kew tank. In studying the genital pouches of specimens taken on September 27 I found below the ectoderm an abundance of ripe spermatozoa; these escaped through the wall of the pouch, which very readily ruptured. Below this layer of ripe spermatozoa, and between them and the "structureless lamella" separating endoderm and ectoderm, I observed (as I had observed previously in specimens from Regent's Park) a firm colourless tissue consisting of small nucleated cells. It occurred to me that these might possibly be ova, and the Medusæ accordingly hermaphrodite. They had not the appearance of ova at this stage, but still I thought it possible that they were very young ovarian cells. I treated specimens with osmic acid, alcohol, and picro-carmine in succession, and cut sections of the genital pouches, with the result of satisfying myself that this dense tissue beneath the loose spermatozoa was *not* ovarian, but consisted simply of the mother-cells of the spermatozoa.

I further tested this view of their nature by isolating a number of the Medusæ in large glass jars which were kept in the lily-house at Kew. After a fortnight (October 8) the gonads or genital pouches had increased in length and bulk both in my isolated specimens, and in those swimming in the tank. On examination, the dense tissue underlying the spermatozoa was found to have disappeared, or rather to have developed itself into additional crops of spermatozoids. Accordingly my hypothesis of hermaphroditism fell to the ground.

It is, however, remarkable that even when half-grown the genital pouches of *Limnocodium* will emit ripe motile spermatozoids upon slight pressure, and that they continue to form these bodies for so long a period of growth. Normally, I am inclined to believe, these spermatozoa are shed by rupture of the sac in incompletely grown individuals, from time to time, whilst new crops are produced from the as yet unexhausted spermatic tissue. This would imply that somewhere in the tank there are eggs or females producing eggs which are to be fertilised by the very abundant spermatic particles.

The tank at Kew was emptied and thoroughly cleaned out about the middle of October. The Medusæ were still to be found, though they had much diminished in abundance. Some of the sweepings of the bottom of the tank were preserved with the intention of replacing the material in the tank, so that the eggs of the Medusæ—if eggs there are—may have a chance of continuing the colony in the coming season.

My object in publishing these notes is that they may be of service to others who may feel disposed to investigate *Limnocodium*, and to search for the females should opportunity again be afforded. I also hope that some suggestions may be offered by other naturalists, which will be of assistance in solving the problems presented.

It is necessary to point out that the obvious plan of searching the sediment of either the tank at Kew or in the Regent's Park for eggs is not feasible. The bulk of the material to be examined is too great, since these tanks have a square area of several hundred feet. There would be a better chance of finding the females (supposing them to be deep-living or sessile) in such a search than the eggs, were it possible to empty the tanks and get at the sediment when a suitable period for such search arrives. But, as a matter of course, the proper treatment of these tanks in connection with the cultivation of plants cannot be interfered with. An obvious suggestion is that of isolating a number of both old and young Medusæ in small tanks, and thus obtaining the means of knowing exactly what becomes of them and of anything they may produce. I have attempted this both in 1880 and 1881, but without any success. The Medusæ isolated, even in large bell-jars holding 5 or 6 gallons of water, and maintained at a temperature of 80° F., do not thrive.

After a time they die. Their ill-health under these circumstances is apparently due not merely to the want of food, since with sufficient trouble the small Entomostraca on which they feed can be supplied to them, but to the very fact of isolation in a small receptacle. They require a large bulk of water. Fluviatile organisms can be kept in a small vessel by means of a constant stream passed through the vessel, and organisms which inhabit small ponds present no difficulty. But lacustrine forms are very difficult to deal with. Should the Medusæ reappear this year, it is my intention (with the permission of the authorities) to partially submerge a vessel with freely perforated sides in the large tank, the bottom of such vessel to be imperforate, and the vessel itself two feet in diameter and three feet in depth. If a sufficient number of the first brood of young Medusæ can be cultivated in this vessel through the summer, both males and females (unless the females have some altogether unsuspected history) will in all probability arrive at maturity, and reproduce in it as they clearly enough have done in the Regent's Park tank between 1880 and 1881. It will then be possible from time to time to examine carefully the contents of this experimental vessel. I need not say that I should be very glad if others would carry out a similar experiment.

E. RAY LANKESTER

ELECTRICITY AT THE CRYSTAL PALACE

II.—*Edison's Electric Light*

THE centre of attraction at the exhibition of electricity in the Crystal Palace, formally opened on Saturday by the Duke and Duchess of Edinburgh, will unquestionably be the show of Mr. Edison. His electric light in the Entertainment Court and the Concert Room is by far the finest ever yet made, and is of itself a spectacle to be remembered. No expense has been spared to demonstrate the power and beauty of his incandescent lamps, and the divisibility of the current to meet the wants of domestic lighting; while Messrs. Verity and Sons have seized the occasion to illustrate their skill and show how eminently adapted the electric light is for ornamental purposes. The heated filament of carbon inclosed in a vacuous bulb of glass is well fitted for all kinds of domestic illumination by reason of its pure and absolutely steady glow, its healthiness and freedom from noxious fumes, and its comparative coolness. But in addition to its superiority over gas, oil, and candles in these respects, the Edison exhibit also proves in the most striking manner its superiority as a decorative light, and its unrivalled capacities for enhancing the artistic pleasures of our homes. Besides giving off no deleterious gases to tarnish gilding or dim the most delicate colours, the incandescent lamp lends itself to the designer's fancies in a way which no other illuminant can; and we may expect something like a revolution in household decoration by its introduction, as well as a new development of the brass-worker and the glass-blower's art.

Before considering the apparatus employed by Mr. Edison at the Crystal Palace for the production and distribution of the light, we shall briefly describe the results. To begin with the Entertainment Court, which is in reality a small theatre, the principal object of interest is a magnificent chandelier suspended from the middle of the ceiling. This beautiful object is in itself a work of art, and sustains ninety-nine incandescent lamps. It is conical in general shape, and is about fifteen feet in height by ten feet in diameter at the lower end; while its weight is half a ton. In device it represents a tapering bouquet of flowers rising out of a golden basket. The stem of each flower springs from a circular brass plate within the basket, and bends over towards the spectator, presenting to him its calyx of coloured glass, in which is fixed an incandescent lamp. The foliage is all of hammered brass, richly gilt, and here and there is mingled with the sun-flower or tiger-lily, and some rambling sprays of fern. The corollas of the flowers containing the lamps, and acting as their shades, are in the form of heaths and harebells, made of glass, and tinted with a variety of colours—pearl, white, ruby, clear olive, and clouded blue. Each lamp projects from the heart of the flower like an enlarged pistil, and throws its light outwards and downwards into the room below. The lights are controlled in three sections by turncocks, like gas, and thus a graduated effect can be obtained, or all the lights may be put on or off at will.

On each side of the stage, which is furnished with a row of twenty-four footlights, there is a pretty candelabra[1] mounted on a short marble column, and representing a rose-bush springing from a golden urn. The stem of the bush is entwined with China roses, and crowned with five upright lamps or candles, like the fruit of the tree. On the left of the stage is hung an exquisite little chandelier or lustre of Venetian glass, which, though far less imposing than its gaudier neighbour in the centre of the hall, is chaster and more elegant, and better fitted for an ordinary drawing-room. It is about four feet high, and consists of loops and festoons of crystal drops on gilded chains, encircled at the bottom by a ring of fourteen lamps; and inclosing higher up a single incandescent bulb of ruby glass under a bell shade of the same material. The use of coloured glass for the vacuous bulb itself is illustrated here, and shows how the light can be tinted to harmonise with any interior furnishing, or suit the taste and eyesight of individuals. The brilliance of the glowing carbon in a transparent bulb is not too strong for the ordinary eye to look at with impunity; but persons of weak sight may have it reduced by the use of clouded bulbs, and students, or those suffering from diseases of the eye can employ bulbs of green or blue glass. Photographers, too, can have recourse to ruby lamps in the development of their negatives.

On the right side of the stage there is a third chandelier of gilt brass, with twelve naked bulbs, a number of single lamps on stands or movable brackets, like gas-jets, with turn-cocks, and either naked or shaded by flat conical reflectors of opal glass. Specimens of these are shown in Figs. 1 and 2. Then there are hall-lanterns of brass, inclosing clusters of bulbs, window-lights, a very handsome billiard lamp, containing six set of twin lamps, shaded from the eyes of the players by opal glass reflectors and crimson fringes, and two handsome drawing-room shade-lamps of the same pattern, each containing a cluster of eight bulbs inside, and one being supplemented by four pairs of naked bulbs outside. Bulbs are also shown burning under water, either clear or tinted, to illustrate the use of the incandescent system in fiery mines, and there is a specimen of a regulator lamp by which the power of the jet can be graduated at will like a gas-flame, by simply turning the cock. This lamp is shown in Fig. 3, the lower being the regulator, which acts by inserting the resistance of a series of vertical carbon rods into the circuit. This is done by turning the screw-piece at the base of the cylinder inclosing the bars. The cylinder is perforated to allow the air to circulate and keep them cool.

In the top of the lamp the novelty is the form of the contact surfaces to prevent sparking or breaking the circuit. These are conical, the small cone seen on the top of the figure being forced away from a conical cup on turning the screw plug. The large surfaces of the cones prevent simultaneously separating, and prevent a large spark. A safe-guard for the lamp against a too powerful current is provided in a short lead wire, seen running across the left of the figure. When the current is too strong this wire fuses, and the current of the lamp is interrupted.

[1] Electrolier and electrolabra would be the corresponding terms.

In addition to these lamps Mr. Edison also exhibits some very handsome sconce mirrors supplied by Messrs. Verity and Sons. One of these is a novelty in its way, since the bulb lighting it is inside the frame, and therefore out of sight. The interior of the frame is, however, whitened, and reflects the light out through narrow panes of clouded glass which flank the central mirror, and the face of the spectator thus illuminated can be seen in the mirror. This is another effect which could not be produced by gas. The other sconces are lit by naked bulbs, supported by in front of the mirrors, curving brass brackets in which the ruling idea of foliage and flower or fruit is elegantly worked out.

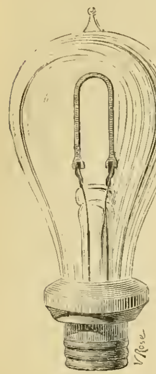


Fig. 1.

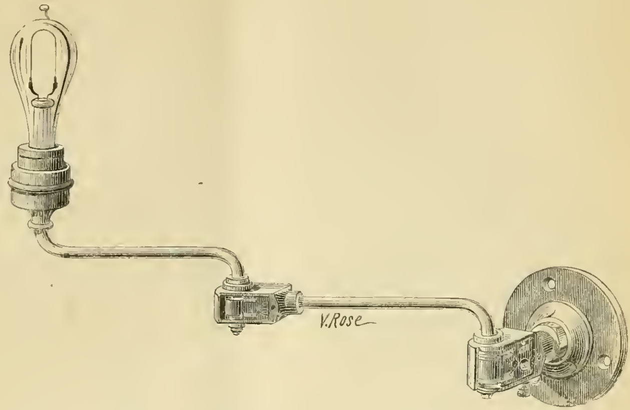


Fig. 2.

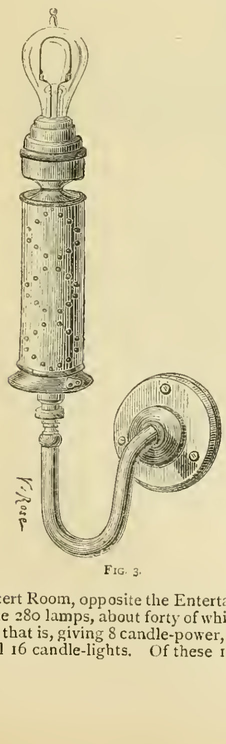


Fig. 3.

In the Concert Room, opposite the Entertainment Court, there are some 280 lamps, about forty of which are termed "half-lights," that is, giving 8 candle-power, or a light one-half of the full 16 candle-lights. Of these 120 are hung in festoons between the pillars of the galleries, the rest being suspended in sets of four under the galleries, or fixed within a large crystal lustre suspended from the roof, and looking like a nest of diamonds. In the Entertainment Court and Concert Room together there are nearly 500 lights, and the stalls in the wide avenue leading to the railway station, have yet to be lighted. In all there will be about 700 lamps required when the exhibit is complete. To drive the 500 lamps now going there are eight dynamo-electric machines at work, and four more are being got ready for the remaining 200 lights. Three Robey engines of 25 horse-power nominal are planted to work these machines, one engine to every four machines. It is usual to allow ten lamps to each horse-power, but what the actual power consumed may be is difficult to state.

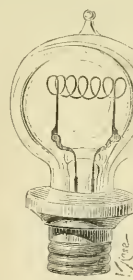


Fig. 4.

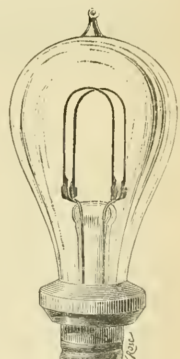


Fig. 5.

The lamp itself consists of a strong bulb of glass about the shape and size of a large Jargonelle pear, say $4\frac{1}{2}$ inches long by $2\frac{1}{2}$ inches in diameter at the thickest part. From the narrow end a tube of glass projects nearly half-way into the bulb, and contains the ends of the copper

conducting wires or electrodes. The inner end of this tube is closed by a flat keel of solid glass, but the wires pass through this into the upper part of the bulb, where they are connected by an electrotype of copper to a fine loop or arch of carbonised woody fibre cut from the silicious skin of the bamboo cane. Mr. Edison exhibits specimens of bamboo from China, Japan, and South America, as well as fibres from Brazil, which he has tested in seeking a good and durable carbon for his lamp. He shows also a number of samples of the carbonised loops made by simple charring in a crucible or by treatment after the Berthollet process, as well as loops of pure graphite very carefully cut. What the particular bamboo is that he has finally adopted we have never been able to learn, but it is probably a variety of the "Shikakuahikee" of Japan, which yield a very close and even skin. The carbon loop is about $2\frac{1}{2}$ inches high, and 1 inch wide, and is so fine that its electric resistance is about 100 ohms. in the "16-candle lamps," and about 50 ohms. in the 8-candle lamps. All the lamps at the Crystal Palace are plain single loop lamps; but sometimes Mr. Edison combines two or more loops, as shown in Figs. 4 and 5. These loops can either be coupled up "in series," or "quantity," and instead of making the loops plain they may be curled into a spiral form. The air being exhausted from the bulb there is no oxidation of the carbon after a short time and Mr. Edison claims that his lamps will last 1000 hours. This at an average rate of between three and four lighting hours per night would give a life of nine months to each lamp; but the estimate may be found a little partial in practice: for though the carbon does no burn, it is doubtless slowly dissipated by the wasting action of the gases and the energy of the current. As Mr. Edison claims to make the lamps at a shilling each, their durability is not so very important as it might at first appear. The Edison dynamo electric machine consists of two vertical electromagnets inclosing between their lower pole pieces of soft iron, a revolving armature. In the armature the usual coils of insulated wire are replaced by longitudinal bars of copper of trapezoidal section insulated from each other by brown paper. These bars are connected to the slips of the commutator in such a manner as to give a continuous circuit through the bars and a continuous current to the brushes when the armature revolves. The main conductor conveying the current from the machine consists of a solid rod of copper in

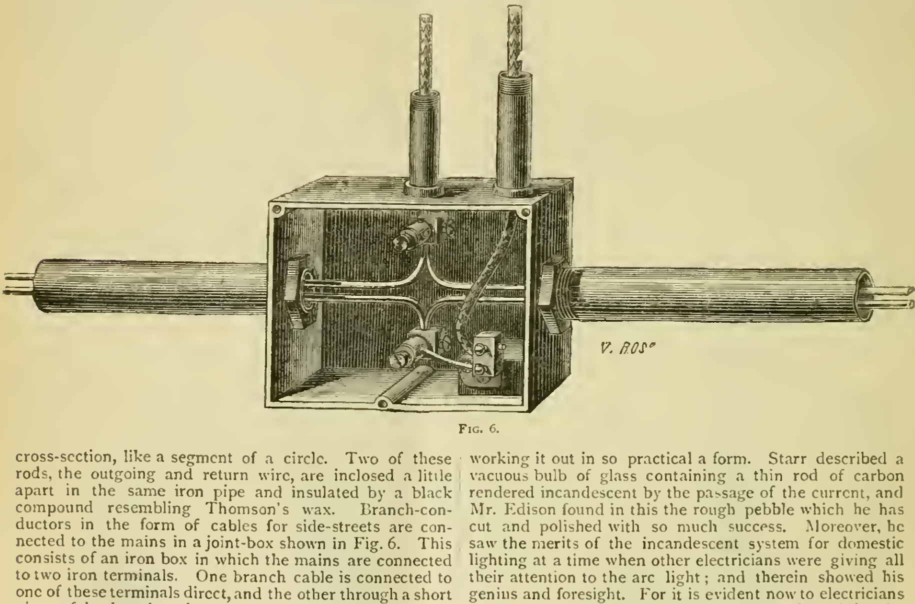


Fig. 6.

cross-section, like a segment of a circle. Two of these rods, the outgoing and return wire, are inclosed a little apart in the same iron pipe and insulated by a black compound resembling Thomson's wax. Branch-conductors in the form of cables for side-streets are connected to the mains in a joint-box shown in Fig. 6. This consists of an iron box in which the mains are connected to two iron terminals. One branch cable is connected to one of these terminals direct, and the other through a short piece of lead to the other terminal. The lead acts as a safety-valve in fusing if the current is too powerful. The box is hermetically sealed, to keep the inside dry. The conductors led into the houses are of a still smaller size, having a diameter of from two to three millimetres; but throughout the whole system the going and returning wires keep together, and the lamps are simply connected across between them. In each lamp, too, there is a similar safety connection of lead to protect the carbon if the current is too strong.

The incandescent system has evidently been brought to great perfection by Mr. Edison, backed as he is by plenty of capital and skilled assistance. Although the idea of it is not new, and was patented in England by Mr. Starr in 1845, Mr. Edison deserves great credit for working it out in so practical a form. Starr described a vacuous bulb of glass containing a thin rod of carbon rendered incandescent by the passage of the current, and Mr. Edison found in this the rough pebble which he has cut and polished with so much success. Moreover, he saw the merits of the incandescent system for domestic lighting at a time when other electricians were giving all their attention to the arc light; and therein showed his genius and foresight. For it is evident now to electricians that while the arc light is well enough adapted for the lighting of large areas, it is unsuitable for small interiors. The practical success of Mr. Edison's system is not thus far a complete justification of his early promises, for the cost is still an unknown quantity, as far as the public are concerned, and there are strong reasons for believing that it will not nearly be so low as the startling figure held out in 1878.

NOTES

At the annual meeting of the Geological Society the medals were presented as follows:—The Wollaston Gold Medal to Dr. Franz Ritter von Hauer, Director of the Austrian Geological Survey; the Murchison Medal to Prof. Jules Gosselet, of Lille

the Lyell Medal to Dr. John Lycett, of Scarborough; the balance of the Wollaston Fund to Dr. G. J. Hinde; the balance of the Murchison Fund to Prof. T. Rupert Jones; a moiety of the Lyell Fund to Prof. Charles Lapworth, Mason College, Birmingham, and to the Rev. Norman Glass; a portion of the proceeds of the Barlow-Jameson Fund to Baron Constantin von Ettingshausen, Professor of Botany at Graz. Mr. J. W. Hulke, F.R.S., was elected President, in succession to Mr. Etheridge.

THE Rev. Thomas Romney Robinson, D.D., died on Tuesday, after a short illness, at his residence, The Observatory, Armagh, at the patriarchal age of eighty-nine years. He retained his mental faculties in surprising activity and vigour to the last.

M. DESOR, one of the last companions of Agassiz in his great Alpine excursions, which led to the discovery of the theory of glaciers, has just died in Neufchatel. M. Desor, although born in Germany, was of French extraction, and had been a naturalised Swiss citizen, and became the president of the National Council. He bequeathed all his fortune to the city for scientific purposes.

DR. W. R. HODGKINSON, Senior Demonstrator at the Royal College of Chemistry, has been appointed to the Professorship of Chemistry and Physics at the Royal Military Academy, Woolwich.

PROFESSORS ROSCOE AND ABEL, as presidents respectively of the Chemical Society and Institute of Chemistry, will hold a reception on the 22nd inst. at the Crystal Palace in connection with the Electric Exhibition.

THE Sanitary Institute is to hold an Exhibition of Sanitary Apparatus and Appliances at Newcastle-on-Tyne, this year, from September 26 to October 21, in connection with the fifth Autumn Congress of the Institution.

ON April 18 next a Congress of Greek physicians and naturalists from all parts of the world will meet at Athens.

THE International Congress for Ethnographical Sciences, called together by the Paris Ethnographical Institution (founded 1859), will meet at Geneva on April 10 next under the presidency of M. Carnot. Besides all the European States, India, Egypt, Japan, Canada, the United States, the Argentine Republic, and Australia will be represented. The Institution includes amongst its main objects the facilitation of the personal intercourse between men of science of all countries, and also the support of exploring travellers. All information regarding the Congress is furnished upon application by M. G. Becker, Lancy, near Geneva.

WE learn from No. 13 of the Johns Hopkins University Circulars (February, 1882) that Prof. Cayley, F.R.S., has commenced residence as Lecturer in Mathematics. He read a paper at the January meeting of the "Mathematical Seminary" entitled "On Two Cases of the Quadric Transformation between Two Planes."

WHILST this winter has been remarkably mild in Western Europe, it has been of quite unusual severity in South-Eastern Russia. The main chain of the Caucasus is covered from the top to the lowest valleys with snow. The great depression of the Kura and Arako rivers looks like a Siberian plain covered with snow. The bright sun of the south seems unable to warm the cold soil, and in the night the small streams and irrigating channels freeze. Even the Mikhael Gulf of the Caspian, south of Krasnovodsk, was frozen from December 19 to January 7, and the thickness of the ice was $4\frac{1}{2}$ inches.

COLONEL BRINE and Mr. Simmons started on Saturday morning from Canterbury in their balloon trip across the Channel, the wind being considered favourable. After getting about thirteen miles out from Dover the aëronauts discovered that the wind backed to the south-west, and thinking discretion the better part of valour they lowered their car into the sea and were picked up by a passing steamer, after having been in the air for about three hours.

INSTEAD of allotting the surplus from the Electrical Exhibition to the new School of Chemistry and Physics, M. Cochery has kept it for the establishment of a laboratory of electricity, which will be under his administration.

A COMMITTEE is being formed at Neuss on the Rhine, with the view of erecting a monument to the late Dr. Theodor Schwann, in the public gardens of that town. Dr. Schwann, as our readers will remember, was a native of Neuss.

THE February number of *Naturen* contains an interesting notice of the changes of movement observable in the Norwegian glaciers, which, as is proved by well-attested local records, have repeatedly advanced and receded within the last two centuries. It would appear that the vast system of the Justedal glaciers has been especially affected by these variations, for here, where the ice has been diminishing since 1750, it had previously been advancing so rapidly, that in 1742 the local magistrate was summoned by the occupants of a hamlet known as "Ni Gaard," Nine Farms, to inspect the damage that was being done, and to grant them remission of their taxes on such lands as no longer admitted of cultivation. The official report states that the glacier had then approached within one hundred ells of the nearest farm, and that in the following year the buildings were thrown down and crushed under the advancing masses of ice. Gradually the other farmsteads disappeared, leaving nothing but the name of the spot to attest that it had once been cultivated. Since this period the Justedal glaciers generally, have been retreating, a fact which was first noticed by Prof. Smith, of Upsala, who, writing in 1817, draws attention to the milder winters which in Scandinavia had characterised the latter half of the last century, while the years 1740-42, which succeeded several hard winters and bad summers, had been so especially inclement that they are known in Norway as the "Green years," from the unripe condition of the corn. This period coincides with the date of the devastations of the Nigaard glacier which, after a prolonged process of diminution has, according to De Seue, been again steadily advancing since 1869. The Folgefon glacier, near the Sörfjord has, as we learn from the report of Sexe, who visited it in 1864, been subject to similar alternations. At the present time it is advancing, its extremity having between 1860 and 1878 been projected 40 metres further forward, bringing it within 200 metres of cultivated fields.

THE meteorological report of the weather in 1881, as observed in Christiania, exhibits the same anomalies that have been recorded in other countries. Notwithstanding periods of exceptionable mildness, the mean annual temperature was 1° R. lower than the normal. The highest temperature (20°·4 R.) was recorded on May 31, the lowest (–18°·7 R.) on January 14. In November and December the temperature was higher than usual, the excess amounting in the latter month to 3°·6 R., which was largely influenced by the abnormal heat of December 28, when the thermometer at noon marked 9°·4 R., a temperature that has never before been reached since the opening of the observatory in 1837; while since 1857 the mean for December had not risen above the freezing point. The rainfall was marked by equally great irregularity in the manner of its distribution, only 5 millimetres being recorded for April, and 102 for August, the former being 19·3 mm. below the average, and the latter 24 mm. above it.

A SERIES of scientific lectures in Chinese to the Chinese schools in Peking, commenced by the American mission, is said

to be attracting wide attention in the Capital, and to have drawn large audiences. Two of the course have already been delivered; the first by Dr. Edkins, the well-known Sinologist, on astronomy, and the second by Dr. Dudgeon, head of the Missionary Hospital at Peking, on the heart and circulation of the blood. Both lectures were copiously illustrated by the magic lantern. It is gratifying to find the missionaries, who are among the small number of people capable of teaching the Chinese in their own language, working thus for the spread of elementary western knowledge amongst the Chinese.

AT the ordinary meeting of the Meteorological Society, to be held at 25, Great George Street, Westminster, on Wednesday, the 15th inst., at 7 p.m., there will be an Exhibition of Anemometers and of such new instruments as have been invented and first constructed since the last Exhibition. During the evening the President, Mr. J. K. Laughton, M.A., F.R.A.S., will give a historical sketch of the different classes of Anemometers, and will also describe such forms as are exhibited.

ACCORDING to the *Annales de l'Extrême Orient*, at the commencement of the year there were in Japan 3929 miles of telegraph line with 9345 miles of wire. The telegrams sent during the year numbered 1,272,756, of which about 96 per cent. were in Japanese, while there were 22,695 international messages. A school of telegraphy has been founded in the capital, the pupils receiving a practical knowledge of English and French. During the year this institution sent 227 young men out to the various telegraph offices. The average cost of sending twenty words in Japanese for a distance of sixty miles is about three *sen*, or one penny, taking as a basis of calculation the line from Tokio to Nagasaki. The average for shorter distances is much greater, being about seven *sen* from Yokohama to Tokio, a distance of only twenty miles. There were 112 offices open to the public, and 70 attached to departments of State, the police, &c.; 53 remained open night and day; 848 Morse instruments were in use at the end of the year, and 29 Bell's telephones.

A VIOLENT earthquake is reported from Tongatabu in the Pacific on November 24 last. The whole island was so shaken that it was almost impossible to remain standing erect. A strong earthquake shock, which lasted twenty seconds, was felt at Bellinzoni, Olivone, and other parts of the Canton of Lesser, Switzerland, on February 27.

THE Russian botanist, M. Smirnoff, who is now in Turkestan, writes to the Russian Geographical Society that the vineyards of the country are quite destroyed by the small parasitic fungus *Erysiple*. He says that he never saw such a dreadful and widely-spread destruction of vineyards as he witnessed in Turkestan. It can only be compared with the destruction by a heavy hailstorm.

HERR HAKONSON-HANSEN draws attention to a remarkable phenomenon due to refraction, observed by him at Trondhjem, on January 17, and similar in all respects to one witnessed by him at the same place on November 15, 1881. On both occasions, at 2.50 to 3 p.m. in the day, a rose-coloured stripe was seen to stretch across the sky from about north-west to east. From the middle of this rose a vertical column of a somewhat lighter red colour, and inclining on its western side to a shade of yellow, the whole being intensely luminous. After remaining visible for about ten minutes, the bright reds and yellows gradually faded away, leaving nothing but a blackish gray streak across the heavens. The sudden and striking apparition of this vertical column recalled, as Herr Hansen observes, the descriptions given in past ages of bloody crosses seen in the heavens, and regarded as prophetic of coming wars and pestilence, and he remarks that if it had been seen at a later period of the day, it might have been taken to be a specially brilliant aurora.

STEAMERS recently arrived at New York report that they encountered immense fields of ice in lat. 45° 48′ N., long. 47° 48′ W. The *Circassian* had to steer south two days to clear them, and the *St. Germain* was fast for seventeen hours in the same pack.

M. SALIGNAC, one of the most active electricians of Paris, has discovered a new regulator which will be one of the curiosities of the next *grande soirée* given at the Observatoire on the 13th inst. Each of the two carbons is supplied with a parallel rod of glass, to which it is attached in a solid manner. These two rods being placed horizontally, are pushed by a spring, and the spark is lighted between them. But between the two glass rods there is a glass stopper which is warmed by the light in such proportion that the rods yield gradually to the pressure of the springs, and the carbons can approach each other, as is required for the constancy of illumination. Our correspondent witnessed preliminary experiments which he states have been a wonderful success.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. G. Richardson; a Common Peafowl (*Pavo cristatus*) from India, presented by Mrs. Walter Crane; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. S. Sidney; a Common Jay (*Garrulus glandarius*, white var.), British, presented by Lieut.-Col. Birch Reynardson; twelve Pink-lipped Snails (*Helix hæmastoma*) from Point de Galle, Ceylon, a nest of Cocoons from Kadur District, Mysore, presented by Mr. J. Wood Mason; a Four-horned Antelope (*Tetraceros quadricornis* ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE VARIABLE STAR U GEMINORUM.—The following interesting note upon a recent maximum of this apparently capricious variable, is by Mr. G. Knott, who writes from Cuckfield on March 6:—"On February 20 I noted it 13·7m. At intervals it seemed to flash out brighter, and there was every indication of a probable rise to maximum. Clouded skies night after night prevented my observing again till March 1, when in a clear interval of short duration I found U, 9·7 mag. *Disk large and ill-defined*. I have observed it since as under:—

March 2 ... 9·9m. Light rather unsteady. Colour, white or bluish white.
,, 3 ... 10·1m. Bluish white.
,, 4 ... 10·5m.

I suppose we may take the maximum to have fallen *not later* than February 28.

The previous maximum observed by me fell on April 3, 1881, the interval in days being 331, which would give 110 days as the period, if we suppose three maxima to have occurred in the interval. The period appears to vary between 75 and 126 days. The star appears to form a kind of connecting link between the *ordinary variable* and the so-called *new stars*, and as the causes which presumably underlie the phenomena are *physical* rather than *geometric*, perhaps we ought not to be surprised that the period has a wide and somewhat irregular range. *The star is a most interesting one.*

It is due to Mr. Knott to add that so far as the published observations of variable stars elsewhere enable us to judge, he has been much more successful than other observers in following the maxima of this difficult variable of late years; such success could only result from very assiduous and careful observation.

THE TOTAL SOLAR ECLIPSE OF MAY.—By way of reply to several inquiries as to the most probable track of the central line in the eclipse of May 16, we subjoin the following points which have been interpolated down from those given for five-minute intervals in the "American Ephemeris." As already remarked in this column, the difference in the place of the moon employed in that work, from Hansen's place, happens, on this occasion, to correspond very closely with the amount of Prof. Newcomb's empirical correction of Hansen's Tables, and hence the path

calculated is likely to be as near to the true one as any prediction we are able to make.

Greenwich mean time, May 16. h. m. s.	Longitude E. ° ′	Latitude N. ° ′	Duration of totality. m. s.
18 22 30	30 18·2	25 50·9	1 9·2
18 23 45	30 58·0	26 11·6	1 10·6
18 25 0	31 37·0	26 31·9	1 12·0
18 26 15	32 15·3	26 51·8	1 13·3
18 27 30	32 52·9	27 11·2	1 14·6
18 28 45	33 29·9	27 30·2	1 15·9
18 30 0	34 6·1	27 48·9	1 17·1
18 31 15	34 41·9	28 7·2	1 18·3
18 32 30	35 17·2	28 25·2	1 19·5

Thus in longitude 31° 37′ E., latitude 26° 32′ N., a point close upon the Nile, the duration of the total phase is 1m. 12s., and the middle at 20h. 31m. 28s. local mean time. The central line crosses the Nile about a degree north of Luxor, one of the stations occupied for the observation of the last Transit of Venus.

A NEW ASTRONOMICAL MAGAZINE.—M. Flammarion has commenced the publication of a monthly periodical intended to give an account of the progress of astronomy and allied subjects in popular language. His first number contains an article on the history of the Observatory of Paris, with illustrations showing the establishment as it existed in 1672, from the frontispiece to Lemonnier's "Histoire Céleste" (a work which has now become somewhat rare), and in its actual state, with the additional grounds to the south of the main building, extending to the Boulevard Arago. The number also includes M. Flammarion's observations upon the brightness of the great comet of 1881, as compared with stars, from June 23 to September 4, commenced at Paris and concluded in the Alps at an altitude of 2000 metres. Referring to Prof. Winnecke having observed this comet as late as January 8, 1882, M. Flammarion remarks: "On n'a probablement jamais suivi une comète à une pareille distance." This, however, is a mistake. The distance of the comet of 1881 from the earth at the time of Prof. Winnecke's observation was 3·08 (the earth's mean distance from the sun being taken as unity): but the following comets were observed at greater distances:—Donati's comet, 1858, to 3·14, Colla's of 1847 to 3·18, the great comet of 1811 to 3·50, Mauvais' Comet, 1848, to 4·40, the great comet of 1861 to 4·70, and the extraordinary comet of 1729 to 5·23, notwithstanding the inferior telescopes of that day. The magazine is well printed and illustrated, and will doubtless be popular, especially with amateurs in France, who appear to be a much more numerous class than formerly.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—There will be an election in next June at Magdalen College to at least one Scholarship in Natural Science, the conditions of election being subject to any new Statutes which may be made by the University Commissioners. The examinatian in Natural Science will be held in common with Jesus College, at which an election will be made to one Natural Science Scholarship, and possibly one Exhibition. Questions will be set relating to General Physics, to Chemistry, and to Biology; but candidates are recommended not to offer more than two of these subjects.

The value of the Scholarship is 80*l.* a year, and of an Exhibition 40*l.* Neither Scholarships nor Exhibitions will be awarded unless properly qualified candidates offer themselves.

Candidates for the Scholarship and Exhibition at Jesus must be natives of Wales or Monmouthshire, or persons who shall have been educated for the four years last preceding their election (or last preceding their matriculation if already members of the University) at a school or schools in Wales or Monmouthshire . . . if any such persons be found of sufficient merit and fit to be scholars of the College in the judgment of the electors.

Mr. J. R. Wynne-Edwards, of Giggleswick School, has been elected to a Junior Studentship for Natural Science at Christ Church, Oxford. At the same examination a second studentship was awarded to Mr. W. H Pendlebury, of Manchester School, and an Exhibition was awarded to Mr. R. W. Lancaster, Commoner of Christ Church. There were thirty-five candidates.

CAMBRIDGE.—From the University accounts for 1880-81 just published, it appears that the disposable income of the year amounted to about 30,500*l.*, of which only about 3300*l.* was from property, while 27,200*l.* was derived from matriculation, examination, and degree fees, and quarterly payments from members of the University. Of this sum over 11,300*l.* was expended for strictly scientific purposes, to which also further receipts from special endowments, amounting to 2950*l.*, were devoted. It cannot be said that the University as such spends sparingly for scientific purposes in proportion to its income.

Mr. Donald McAlister has been approved as a teacher of medicine, and Mr. A. Sedgwick as a teacher of comparative anatomy, for the purpose of giving certificates to medical students.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, February 8.—R. Etheridge, F.R.S., president, in the chair.—Ridley Henderson, William John, and James Robert Millar Robertson, M.D., were elected Fellows, and Prof. S. Lovén, of Stockholm, a Foreign Member of the Society.—The following communications were read:—Description of some Iguanodon remains discovered at Brook, Isle of Wight, indicating a new species, *Iguanodon Seelyi*, by J. W. Hulke, F.R.S.—On a peculiar bed of angular drift on the high Lower Chalk Plain between Didcot and Chilton, by Prof. J. Prestwich, F.R.S. In making a railway from the main line to Chilton, this bed of drift was cut through for a depth of about 1¼ mile. It lies on a flat plain extending from the foot of the escarpment of upper chalk to the top of that of lower chalk. In places it is full 28 feet thick. At first a fine chalk rubble, it becomes after a while coarse, and is divided by clay beds into an upper and a lower deposit. Here small boulders and bones occur, the latter much shattered; but *Elephas primigenius*, *Rhinoceros tichorhinus* (?), *Bison priscus*, *Cervus tarandus*, *Equus*, &c., have been identified. The boulders are Sarsen-stone, and there are small fragments of flint. Shells of *Pupa marginata*, *Helix hispida*, and *H. pulchella* have been found. The drift (which is widely spread) is from 150 to 260 feet above the Thames, at highest 407 feet above the sea. The author compares it with the rubble-beds overlying the raised beaches of Sangatte and Brighton. It is unconnected with any river-course, is not of marine origin, and its materials, where not local, are derived from the southward.

Anthropological Institute, February 7.—F. G. Hilton Price, F.S.A., treasurer, in the chair.—It was announced that the following new Members had been elected since the last meeting:—Dr. Brabazon Casement, F. T. Hall, Miss Marshall, R. M. Connolly, Mrs. R. M. Connolly, T. Dixon, Mrs. T. Dixon, W. K. Foster, T. Ridgway.—Mr. Edward C. Hore read a paper on the twelve tribes of Tanganyika. The author described the distribution of the tribes in East Central Africa: A narrow margin of a doubtful civilisation on the east coast—one to two hundred miles of small native tribes fast losing their distinctive nationalities and tribal customs and arts, and mixed with semi-civilised half-castes—then a narrow interval, more or less desert, seems to be as well the refuge of robbers and renegades, as a natural boundary between the first-mentioned tribes, and the next tract of from two to four hundred miles occupied by tribes of uneasy and apparently warlike aspect, and retaining to more considerable extent the original arts and customs; another narrow border of debateable country again separates these from the more prosperous, peaceful, and civilised tribes of the equatorial lake regions, a few of which the author described. The more northern tribes on the lake are an active and handsomely formed people, with obvious traces of the Abyssinian race, but many distinct differences are noted amongst the twelve tribes. The writer laid stress upon the fact of having lived and travelled among these tribes for four years, and never having failed in making some friendly negotiations with those visited. Three stations have already been occupied by the London Missionary Society, who will shortly send out a steel vessel to navigate the lake and maintain more stations on its shores.—Mr. George W. Bloxam read a note on a Patagonian skull brought from Carmen, at the mouth of the Rio Negro [lat. 44°], by Capt. Hairby.—A paper on the Napo Indians, by Mr. Alfred Simson, was read.

Royal Horticultural Society, February 14.—Sir J. D. Hooker in the chair.—*Proliferous Acorn-cups:* Sir J. D. Hooker

exhibited malformed cups of *Quercus Ilex*, the evergreen Oak, received from Mr. F. Moore, of the British Museum. The tree grows on the cliff's edge, in the Isle of Wight. Minute acorns appeared to have been produced in the axils of the bracts which formed the cups.—*Carnation Disease:* Mr. W. G. Smith exhibited specimens of carnations received from Dr. Hogg, attacked by the nematoid worm, *Anguilula.*—*Root Malformation:* Dr. M. T. Masters showed a specimen of elm-root much distorted in places, in consequence of meeting with obstructions in growing in Lias limestone rock. It was lately figured and described in the *Gardener's Chronicle* (p. 147), and was received from Mr. Ingram, of Belvoir Castle.—*Variation in Pear-Leaf:* Mr. R. D. Blackmore exhibited a three-lobed leaf which had been produced after root-pruning, such being in this case a reversion to the primitive character of the plant. Mr. Henslow remarked that in some cases the change from a simple to a lobed and compound state is the result of further development, as may be easily traced in blackberries and raspberries.—*Apparent Superfœtation in the Pea:* Mr. J. Laxton, of Bedford, forwarded a communication, describing some experiments in fertilising a flower with the pollen of six other varieties. The conclusions he drew from the appearance of the peas and flowers subsequently produced by the seedlings, were that (1) pollen of more than one variety of pea used to cross-fertilise the same flower, may influence more than one ovule in the same ovary: (2) that there is some evidence of the pollen from more than one variety affecting the same ovule.—*Report on Winter Losses, &c., in Plants:* The secretary, the Rev. G. Henslow, gave an account of the progress he had made in compiling statistics for a report on the meteorological phenomena of, and consequent injury to plants in severe winters. He had obtained particulars of severe winters from A.D. 220 to 1881; but those during which destruction of, and injuries to plants had been specially recorded, were the following eight:—1851-52, 1852-53, 1859-60, 1860-61, 1864-65, 1878-79, 1879-80, 1880-81. He had collected all the information he had at present been able to find with reference to these winters, and had drawn up, first, a short account of the principal meteorological phenomena of the year *preceding* each winter, as well as of the winter itself—as the behaviour of a plant under frost so much depends upon its previous conditions; in each case such was followed by details of injuries to and losses of plants over as many places in the British Isles as possible. The importance of registering meteorological phenomena and the losses in several winters lay in the fact that the conditions of the winters respectively differed in many ways from one another. The consequence was that *the immediate cause* of plants succumbing to frost was not always the same. There would be an Introduction dealing with several interesting matters bearing on meteorology and plant-injuries, and he proposed completing it with copious indices, so that no difficulty would be met in finding the exact behaviour of every plant in any country and in any winter. A discussion followed, in which the great importance of elaborating the report as fully as possible, and of speedily publishing it, were insisted on.

Victoria (Philosophical) Institute, March 6.—A meeting of this Society took place at its house, 7, Adelphi Terrace, when a paper was read by Mr. J. E. Howard, F.R.S.

Paris

Academy of Sciences, February 27.—M. Blanchard in the chair.—The following papers were read:—On double salts of mercury, by M. Berthelot. This relates to chlorobromides, iodo-bromides, and chlorocyanides of mercury, iodocyanide and bromocyanide of mercury and potassium, &c.—On the action of strong doses of strychnine on the motivity of nerves in mammalia, by M. Vulpian. They abolish the motivity in mammalia as well as in frogs. The quantity of strychnine necessary is greater than that of curare for the same result. (Nicotine, too, in sufficient dose, abolishes the motivity of motor nerves).—Induced currents of polar interversions, by M. Du Moncel. The currents from displacement of a coil on an iron bar, through a fixed magnetic field, are not of the same nature as those from displacement (in a fixed magnetic field) of this bar, reacting directly on the coil. In the former case those generated by each half of the magnetised bar are in contrary directions, whereas in the other case they are always in the same direction, and their intensity increases with the amount of displacement, but it becomes almost nil in a complete movement of the coil in the former case.—Colouring-matter formed in flour-paste, by M. Lecoq de Boishaudran. Violet is sometimes formed by a small organism in the surface-cells of paste kept long in moist air. Different atmospheres were tried with the (fertilised) paste, and acetic acid vapour seemed the most favourable to production of the colour. The colouring matter is insoluble in water, but soluble in alcohol and ether; in the dry state it has a metallic lustre, like aniline colours. The author describes its spectral and other properties.—Geological and zoological relations of Campbell Island with neighbouring southern portions of land, by M. Filhol. The two principal geological elements of Campbell Island are a band of limestone, and lavas (the former anterior as a formation). The island seems to have appeared in the end of the Pliocene epoch. The New Zealand Eocene, Miocene, and early Pliocene lavas are quite different from those of Campbell, which contain mineral anorthite (a known characteristic of post-pliocene lavas). The geological age of the island is determined by the epoch of the volcanic eruptions. M. Filhol finds his conclusion confirmed by zoology.—On the physiological character of tendinous contraction, by M. Guérin. This contraction has been supposed of *reflex* order, a return action of the spinal cord, provoked by direct excitation of the nerves in the tendon. M. Guérin here contends that it is absolutely of the same order as muscular contractility, tendons showing both voluntary and involuntary contraction, like muscles.—On the employment of bitumen of Judæa against vine diseases, by M. de Lafitte. He recalls earlier observations on the subject than those noticed by M. Abric, by Count de Bertou.—M. Maumené, in a provisional note, said he was able to offer incontestable proof of the individual existence of H_2N, and its decided alkalinity with regard to active colours and acids. He hopes to do the same for HN.—Observations of the comet g = VIII. 1881, and of planets (221) and (222) at the Paris Observatory, by M. Bigourdan.—Observations of the planet Palisa (221) at Marseilles Observatory, by M. Borrelly.—On the successive differentials of functions of several variables, and on a property of algebraic functions, by M. Darboux.—On the integration of differential equations by series, by M. Poincaré.—On certain uniform functions of two independent variables and on a group of linear substitutions, by M. Picard.—Gastric microzymas and their digestive power, by M. Bechamp. He isolated some from the juice obtained with artificial fistulas. Their action on fecula, cane-sugar, fibrine, caseine, and primov-albumen is described. They do not act on albuminoid matters in neutral matter. By their power of action in an acid medium they are distinguished from pancreatic microzymas; the latter, too, give crystallisable compounds of decomposition, as leucin and tyrosin, while the former do not.—New observations of apparent death in new-born infants treated successfully with a bath at 50°, by M. Campardon.—Analysis of a volcanic ash ejected by Etna on January 23, 1882, by M. Ricciardi. This contained silica 37·82, sulphuric acid 20·57, alumina 9·97, protoxide of iron 14·05, lime 11·98, with a little magnesia, chlorine, soda, and potash. The recent appearances of Etna seem to indicate a fresh paroxysm of the volcano.

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THURSDAY, MARCH 16, 1882

ARISTOTLE ON THE PARTS OF ANIMALS

Aristotle on the Parts of Animals. Translated, with Introduction and Notes, by W. Ogle, M.A., M.D., F.R.C.P., sometime Fellow of Corpus Christi College, Oxford. (London: Kegan Paul and Co., 1882.)

THE translator and commentator of this learned work, in speaking of the many erroneous statements in the text of the master, tells us we have only to remember the strange vicissitudes to which the original manuscripts of Aristotle's treatises are said to have been subjected, to obtain a fair reason for the occurrence of these errors. "Hidden under ground in the little town of Scepsis, to save them from the hands of the kings of Pergamus, who were then collecting books to found their famous library, and who, in so doing, apparently paid but little regard to the rights of individual owners, they were left for the better part of two centuries to moulder in the damp, 'Blattarum et tinearum epulæ"; and when they were at last brought to light fell into the hands of Apellicon of Teos, a man who, as Strabo says, was a lover of books rather than a philosopher, and who felt no scruple in correcting what had become worm-eaten, and supplying what was defective or illegible."

In putting this explanation of the errors found in the works of Aristotle before his readers Dr. Ogle seems to have ignored another explanation, which has also been supported, namely, that Aristotle himself intentionally rendered some parts of his treatises obscure. Certain of our English classics have quoted or referred to the correspondence reported to have occurred between Alexander the Great and Aristotle. Alexander having heard, while he was in Asia, that the books of his master were exposed to public sale, is reported to have expressed himself as extremely disgusted that such profound knowledge was laid open and made plain to common understandings, and wrote to the master urging this complaint, and that when the doctrines and precepts communicated by him in private were spread over the world, he should have no wisdom to boast of above the meanest of his subjects. To this Aristotle is said artfully to have replied that he had indeed exposed his works to public sale, but had cast such a veil over them that not one eye in a thousand would be able to discover what lies concealed under them. It had, we think, been fortunate for Aristotle if the mystery made to surround his works had been confined to the little town of Scepsis, and if the many prevarications in respect to them had been confined to the hands of Apellicon, of Teos. For, until recently, it has happened that Aristotle generally has been read and written upon by lovers of books rather than philosophers, and that he has, consequently, been misrepresented high and low, far and wide. Of Aristotle indeed it may be said as Antony said of Cæsar—

> The evil that men do lives after them;
> The good is oft interred with their bones.

He is much more remembered by the masses from the infirmities which are attributed to his career, than from the details of his work. The picture of his personal appearance and manner, his effeminate voice, small eyes, spindle shanks, love of dress; his withdrawal from the Academy; the treatment of him by Plato as a truant and fugitive, who, like an insolent chicken, pecked at his mother hen; his bluntness and supposed discourtesy to his pupil Alexander; his retirement to the court of Hermias, and his assumed intrigues with that tyrant; his marriage with the sister or concubine of the tyrant, and the absurd homage he is declared to have paid to the woman of his admiration; these are all topics which, true or false, have floated down and connected themselves closely in the popular mind with Aristotle as a man living a strange life rather than as a philosopher living a life of philosophy.

They who, irrespective of all these reflections, have tried to read this master from himself, and, with singleness of mind, to understand him in his greatness, will feel no little delight in studying the volume which Dr. Ogle, with learned love for his theme and its author, has put before the world, and for which all scientific men will feel deeply obligated. It is not only that in 140 pages of fine English he has translated this work of Aristotle "On the Parts of Animals," but that he has also written an "Introduction" of thirty-three pages, which prepares the mind of every student for the reception of what is to follow, and has added 111 pages of closely-printed matter, containing notes of an explanatory kind bearing upon all the doubts and difficulties of the text.

The introduction to the work brings before us the mind of Aristotle in respect to his ideas of the origin of created things. In his period, as in ours, there were two schools of philosophical reasoners on beginnings. There was a school which fancied it had found an adequate cause for the phenomena in the necessary operations of the inherent properties of matter. There was another school which discovered a solution in the intelligent action of a benevolent or foreseeing agent which they called God or Nature. Between these opposite views, says our author, Aristotle had to decide, and he decided for neither exclusively, but for both, although in very unequal degrees. "The motions of the heavenly bodies are governed by necessity and by necessity alone. But in the works of nature, that is, in the phenomena of terrestrial life, this necessity is a comparatively unimportant factor." Most is the outcome of design. Still some part, though but a small one, is the result of necessity. There is indeed one sense in which everything in the animal body may be said to be the result of necessity. When a man builds a house, he must, in order to realise his plan, of necessity have walls, roof, and the like. To have these he must first have bricks, stones, mortar, and what not; and again, to furnish these, clay, lime, and the other necessary materials. So it is with the animal body. The design of nature cannot be carried on without the necessary antecedents. In this sense then all parts of the body, and all the successive stages by which they are developed, one after the other, may be said to be the result of necessity, for all must necessarily be there if the plan of nature is to be realised.

From the materialists, however, Aristotle is shown to differ. They contended "that organisms are evolved as necessary consequences of the inherent properties of matter." This Aristotle admitted and disputed. In some measure he considered that what they said was true, but

that measure is small, for nature, in making plants and animals, can but use such material substances as exist; she does the best she can with the materials that are at hand, but the properties of those materials are beyond her control, and such consequences as follow upon those properties are the results of necessity.

Dr. Ogle, describing this view of his author, refers to the singular reference which Galen long after made to the same view, and to the criticism Galen offers on the Mosaic tradition of the creation, a work he had evidently read with much care. Galen disputes with Moses on the point that the Creator can make an animal of any matter he chooses—a man from a stone, an ox from dust. "This," says Galen, "we deny. The laws of matter are antecedent to the Creator, and obligatory upon Him."

Aristotle in his teaching was as little Agnostic as Moses himself. The creative mind, the mind that is like to the human mind, only so infinitely mightier and more original in design, is in nature, and, whether as first or second, is sufficiently above human nature as to be to it a creator, a designer, a maker. "It is ridiculous," he says, "to suppose that such phenomena as those of organic life are merely the result of chance." The very essence of chance is uncertainty. Chance is the principle of the inconstant. "But the phenomena in question present a high degree of constancy, and can be foretold with more or less of precision. It is quite plain that, besides the necessary forces of matter, there is something else at work which guides and co-ordinates these, so as to make them converge to a predetermined end. If a man cannot see this, it is absurd to argue with him; as well try to convince a man born blind, who denies the existence of colour. You see a house or a ship, and without hesitation you infer that such house or ship was made for the purposes to which ships and houses are subservient. Why? Because they are manifestly adapted to those purposes. Why, then, when you see a plant or an animal with equally manifest adaptations do you hesitate to draw a similar inference? True, in one case you can see the agent at work, while in the other the agency is invisible. But why should this make any difference? The agency in the latter case is invisible because it is an internal force, a something acting inside the material. It is as though the invisible shipwright were away and his art were inherent in the timber itself. Moreover, if the agency itself is out of sight, the model from which it works is visible enough, is as visible and palpable as the model of the ship or the plan of the house, and, like them, examinable before either is constructed." Could Aristotle have seen at work one of our modern power looms and have observed how, so long as it was fed, it produced results that unconsciously converge to a predetermined end, he would have drawn from this source another and striking illustration. He would have said here is another instance of an invisible agency working as if the art were truly inherent in the thing itself. It is matter in motion and in direction, producing something by fixed rule, but dependent, nevertheless, on something else which is independent and antecedent.

The great argument left behind, we follow the master to lower but still exalted fields of thought, speculation, and description. We follow him from the metaphysical to the physical, from the formative principle to the things that are formed, and from these in their details rather than in their mass. It is in this part of the original work that the critic comes in with power, and is able to try the quality of Aristotle by the hard test of examination of fact, by the side of statement. Thus adjudicated upon, Aristotle is found to be wanting, or, to use a word that has been applied to him, a "failure." He is said to fail in description of objects actually before his eyes. He is said to fail in generalisation, to have been hasty in generalisation, and to have reasoned on too small a basis of facts. Lastly he is said to fail in method, a failure which was certain to follow if the facts and the generalisations from them are both at fault.

Against all these charges Dr. Ogle defends Aristotle with true and honest skill. He does not defend error nor gloss over defect. He takes the natural common-sense view that Aristotle, in the conditions under which he lived and worked, performed the most signal services: that when he failed to see as we see, he failed because he had no means of seeing; that when he failed to generalise correctly, he failed because the stage to which biology had attained in his time made failure a matter of necessity; that he failed in method because in fact his was the first method, and because verification, which is essential to perfection of method, "does not find its proper sphere in the early condition of a nascent science, when the generalisations are merely provisional, and the false yet necessary precursors of more accurate ones."

The defence really leaves nothing to be desired; it is that which the master would, we believe, have made of himself by himself, could he speak for himself.

If there be one observation which in difference and in deference, we would offer in respect to this defence, it is on the comparison which is drawn between the Timæus of Plato and the work of his contumacious pupil. We admit that it "is the gap which separates the man, Aristotle, from his predecessors, not that which lies between him and his successors which gives the true measure of his position." We admit that when any one compares Aristotle's physiology with that of the Timæus, there is a wide distinction, but are we, really, in the transit "conscious of passing into an entirely new order of things?" We cannot declare this possible with such confident affirmation. It may be fairly said that a great deal in the Timæus is of airy and fanciful construction, but we do not think it fair to affirm that the construction is one "in which imagination alone supplies the foundation, and in which facts, if introduced at all, are introduced merely as ornamental additions in no wise essential to the fabric." This is a harsh judgment, and the more so because we are bound to take Plato as the prompter of Aristotle, and the teachings like those in the Timæus, with all the imaginings and poetry, as the promptings of the "Parts of Animals." To our minds it would be only just to say that the "Parts" was written on the Platonic design, and that if the teachings of Plato had not been placed before Aristotle his more correct and matter-of-fact work had never been born.

The "Introduction" of Dr. Ogle is followed by a chapter entitled "The Main Groups of Animals," in which the chief groups recognised by Aristotle are arranged as follows:—

I. Sanguineous Animals (Vertebrata). A. Vivipara (Mammalia). 1. Man; 2. Quadrupeds; 3. Cetacea. B.

Ovipara. α. With perfect ovum. 4. Birds; 5. Quadrupeds and Apoda (Reptiles and Amphibia). β. With imperfect ovum. 6. Fishes.

II. Bloodless Animals (Invertebrata). α. With imperfect ovum. 7. Malacia (Cephalopods). 8. Malacostraca (Crustacea). β. With scolex. 9. Insecta (remaining Arthropoda and some Vermes). γ. With generative slime; buds; or spontaneous generation. 10. Ostracoderma or Testacea (Mollusca excepting Cephalopods). δ. With spontaneous generation only. 11. (Zoophytes).

After this the text of Aristotle follows in four books, preceded by a Synopsis, and succeeded by the Notes, to which we have already directed attention. How excellently the notes are used to illustrate the text may be shown by one or two quotations. In Book III. Chap. V. Aristotle describes "that in animals of great size the heart has three cavities; in smaller animals two; and in all at least one."

"The reason for this, as already stated, is that there must be some place in the heart to serve as a receptacle for first blood. But inasmuch as the main blood vessels are two in number, namely, the so-called great vessel and the aorta, each of which is the origin of other vessels; inasmuch moreover as these two vessels present difficulties, it is of advantage that they also shall themselves have distinct origins. This advantage will be obtained if each side have its own blood and the blood of one side be kept separate from that of the other."

So much for the text. The notes in the most useful manner explain away one attributed error by Aristotle, while they remove one apparent error. They show that the statement universally made by writers on physiology that up to the time of Galen all philosophers supposed that the arteries contained nothing but air is incorrect, inasmuch as the text shows that Aristotle knew perfectly well that the arteries contain blood. They show again that Aristotle's apparently erroneous view about the cavities of the heart does not prove him ignorant. The three cavities he refers to are the right ventricle, the left ventricle, and the left auricle. He omitted the right auricle simply because he looked on it as a venous sinus, a part, not of the heart, but of the great vein, *i.e.* superior and inferior venæ cavæ. That he so regarded it is plain from his always speaking of the superior and inferior venæ cavæ as forming a single vessel, not two distinct vessels, and that the heart appears very much like a part of the great vein, being interposed between its upper and lower divisions.

Turning to another note bearing on a different, and, as we should now say, a chemical subject, we are offered an insight into the views of the philosopher, on the composition of natural substances. In the first chapter of the second book, the philosopher, in speaking of composition, says that there are three degrees of composition; and that the first of these, as all will allow, is out of what some call the elements, such as air, earth, water, fire. Perhaps, however, he adds, it would be more accurate to say composition out of the elementary forces; nor indeed out of all these, but of a limited number of them. With this observation as a text, Dr. Ogle explains that Aristotle in his other works is seen not only to look upon compounds as combinations of elements, but indeed to have a clear conception of the distinction between chemical combination and mere mixture: "for of the former he says that the combining substances disappear with their properties, and a new substance with new properties arises from their unification. In the latter, the mixed substances remain with all their properties, and it is merely the imperfection of our vision which prevents us from seeing the particles of each lying side by side, and separate. Had we the eyes of Lynceus, we should do so, however intimate the mixture might be." This knowledge is remarkable, though it may not be complete, or may not be completely expressed. It suggests an anxious desire to know more of the sources of knowledge from whence this master drew his chemical learning.

One more illustration from these useful notes belongs to the domain of natural history, and is connected in a way, singularly interesting, with history in a more general sense. Speaking in Book III. Chapter II. of the right and left organs of the bodies of animals, Aristotle says that the horns of animals are, in the great majority of cases, two in number. There are, however, exceptions, he thinks, to this rule in respect to the horns, for there are some that have but a single horn—the Dryx and the so-called Indian Ass. In such animals the horn is set in the centre of the head; for, as the middle belongs equally to both extremes, this arrangement is the one that comes nearest to each side having its own horn. Dr. Ogle, in his note on this passage, points out that the account of the Indian Ass, with a solid hoof and a single horn, was taken by Aristotle from Ctesias, and that it has been plausibly conjectured that the Indian Rhinoceros (*R. unicornis*) is the animal meant; for though, he says, this animal has three toes, they are so indistinctly separated that the real character of the foot might easily escape a casual observer. At the same time he observes that on the obelisk of Nimroud, made long before the time of Ctesias, there is represented a rhinoceros with feet distinctly divided into toes. An argument on the side of this supposed identification is, he adds, furnished by the fact that the horn of the Indian Ass was supposed to have certain magical powers, so that a cup made from it gave the drinker immunity from poison, as is related by Philostratus in his life of Apollonius; whilst similar virtues are assigned, in the East, to rhinoceros horn, even in the present day. If the one-horned ass of India be the *Rhinoceros Unicornis*, may not the asses with horns named by Herodotus as among the animals of Lybia, be the two-horned Rhinocerotes of Africa?

We have selected three illustrations of text and notes, one from anatomy proper, another from chemistry, a third from natural history, for the purpose of giving the reader a taste of the useful and most interesting study that lies before him when he takes up this book. We have rarely seen a volume which so intimately connects the science of the remote past with the science of the present, and which bridges over the distance as this book does. If there be a fault in it, it is that of condensation. In trying to compress and compress, and again compress, Dr. Ogle gets into the mode of using the first letter of the name of his author or book in his references; he also, for the same reason, in his note references, omits the page of the volume, and, as he does not supply a complete key to his method, he is sometimes, like "Bradshaw," rather vexatious, especially when his follower is anxious to discover quickly how to travel with facility from one point to

another. On this detail, however, it were ungrateful to dwell with too much emphasis, and the more so as our own slowness of perception may have added greatly to the difficulty. It is far more pleasant in concluding, to propose to him a hearty vote of thanks, and to express the earnest hope that he will soon place before us some other classical work once buried in Scepsis or elsewhere, in similar English dress and form.

BENJAMIN WARD RICHARDSON

FLAMMARION'S "ASTRONOMY"

Les Étoiles et les Curiosités du Ciel. Par Camille Flammarion. (Paris: C. Marpon et E. Flammarion, Éditeurs, 1881.)

WHATEVER may have been the cause of that development of astronomical taste in England which would so greatly astonish our resuscitated forefathers, and is a puzzle to some plain-thinking people even at this day, the fact admits of no doubt; and a very cheering fact it is to those who value the intellectual and æsthetic progress of their fellow-countrymen. But it is perhaps not so generally known that a movement of the same nature has been in progress among our neighbours across the Channel. It originated later in point of time; for France had entered into no such competition when the Herschels Lassell, Dawes, Smyth, and other non-professional observers were attracting the notice of all Europe by their discoveries; and we recollect, less than twenty years ago, having heard from M. Léon Foucault a candid admission of the inferiority of his own country in amateur observation. But the Gallic mind is more rapid in its movements than our own; and though later in the field we are not sure that they are not shooting ahead of us in these matters in a way that we in general are perhaps hardly prepared to expect. At least, the fact mentioned in the volume before us, that during two years previous to last October, 300 telescopes had been sold to French purchasers, may be accepted as rather a startling proof: and not less so is the extraordinary circulation of the works of M. Flammarion, whom we may justly call the leader of the movement. As many as 50,000 copies in two years have been printed of his "Astronomie Populaire," of which "Les Étoiles" is considered the supplement; his "Merveilles Célestes" have reached 38,000; and his "Pluralité des Mondes" has come out in a 30th edition; to say nothing of other works of remarkable acceptation. Nor is it probable that the success of this publication will fall below that of its predecessors, treating as it does of a most interesting subject in an especially agreeable and familiar way. It is certainly not a volume which an English publisher would like to risk—an octavo of the largest size, of nearly 800 pages, and thick and heavy in proportion; anything in short but a handbook; but this, which would discourage an English buyer, is evidently no objection in the eyes of a Parisian firm. And it must be owned that in many respects it may well command a wide circulation. The idea is that of exhausting all the wonders of the sidereal heavens that the naked eye can reach, and describing their telescopic aspect; and it is excellently carried out for popular purposes: and we may add in certain respects for scientific ones also. The great value of the work consists in the especial pains taken with the probable changes of brightness in a multitude of naked-eye stars, not included in the ordinary enumeration of variables; but it is interesting in many other respects; and the close is enriched with a number of catalogues of telescopes, double and coloured and variable stars, their spectra, proper motions, parallaxes, and other data; together with many descriptions of planets, comets, &c. In short, it is a mine of information for those who do not care to dig deep; and those who would desire more authenticated and *weighted* details (observers will understand the word) may yet meet with much of interesting and valuable suggestion. The book has, however, some drawbacks which ought to be noticed.

Among many useful and some needless illustrations, there are a few (as that of the nebula in Andromeda, where the canals are invisible) of a very inferior stamp; and it is not free from carelessness in assertion, and even misleading statements; for instance, where Hevel is represented (p. 403) as never having in his life used the telescope for purposes of observation. The author should have said, as applied to divided instruments; or we might think he had forgotten the "Selenographia." Nor can we suppose that he made much inquiry as to the classical meaning of "in diem" (p. 525) when he rendered it "pendant le jour." The mythological part is more amusing than valuable: more agreeable perhaps to French than English taste; the theological—if it may be so called—is not only out of place, but worthless.

However, on the whole, the work displays a vast amount of industry and a wonderful range of knowledge; and the enthusiasm of the author for his subject is truly refreshing. Even when a process of unacknowledged appropriation has been indulged in, the borrowed plumage has been so ingeniously adapted and so gracefully worn as almost to claim unmerited forgiveness; but whencesoever his materials may be drawn he manipulates them with accomplished dexterity. His facile and lively style carries us most pleasantly along, and if his passionate eloquence is occasionally rather turgid for our more moderate temperament, it is sometimes exceedingly powerful and impressive. A more thoroughgoing manual might be produced for close practical study; but—allowing for the defects that we have mentioned—nothing that we know of as yet equals it for familiar use and attractive illustration.

OUR BOOK SHELF

Populäre Astronomie von Sim. Newcomb, Astronom in Washington. Deutsche vermehrte Ausgabe, bearbeitet durch Rud. Engelman, Dr. Phil. (Leipzig: Engelmann, 1881.)

THIS is much more than a simple translation of Newcomb's "Popular Astronomy," reviewed in these pages at the time of its publication. The editor thinks that as the original work was mainly written for American students, it would only be fair to German students and astronomers that the German edition should be adapted to a German standpoint. At the same time there is little trace of any special nationality in this edition, the aim of the editor having been rather to make it as complete and comprehensive as possible. Considerable additions have therefore been made both to the text and the illustrations, all of them we think improvements. In the second part, for example, much additional information has been added with reference to instruments and methods; additional

details are given on the last transit of Venus, on spectroscopic methods, photography and photometry, &c. In the third part additional data are given with reference to the sun, its temperature, spots, rotation, spectrum, &c.; the chapter on Comets has been to a great extent re-written, and additional recent data given with respect to meteorites. Part 4, referring to stars and star-systems, astro-physical research, the development of our earth, &c., has also been considerably modified and added to. Several important modifications have also been made in the Appendix. The literature of the subject has been considerably extended and rearranged, while a series of biographical sketches of astronomers from the earliest date down to the present time has been added, a feature of great interest and utility. As frontispiece there is a fine portrait of Sir William Herschel. These are a few of the modifications which have been made in the German edition of Prof. Newcomb's work, some of which the author may consider it advisable to adopt in a new edition.

The Chemical Cause of Life Theoretically and Experimentally Examined. By Oscar Loew and Thomas Bokorny. *Brochure.* (Munich, 1881.)

THIS is a very important addition to our knowledge of the chemistry of plant life, or rather perhaps of the chemical reactions of "living" protoplasm. It is divided into two parts, a theoretical and experimental, following the idea first started by Pflüger concerning "physiological combustion in the living organism." One of the authors has already (*Pflüger's Archiv*, xii. 510) enunciated an hypothesis as to the formation of albumin by condensation of aldehydic groups with amido groups. As Nägeli has shown, various varieties of mould and Bacteria are able to build up the very complex albuminoid groups from relatively very simply constituted bodies like ammonic acetate, also from bodies like sugar, glycerine, &c , in the presence of ammonia or ammonia salts; it may be assumed that the same atomic group is split off and assimilated by the organism. The authors are of opinion that a group CHOH isomeric with formic aldehyde is the first or starting group in the formation of albuminoids. Such a group might possibly be formed, for example, by the oxidising action of moulds on acetic acid; or it might be split off from compounds where it already exists, the neighbouring group becoming fully oxidised. Considering that ammonic acetate and methylamine suffice under proper conditions for the building up of albuminoid groups, an otherwise constituted body than aldehyde can scarcely be considered. As the proportion of carbon to nitrogen in albumin is as 4 to 1, four such aldehyde groups may be imagined to combine with one molecule of ammonia to a group $\begin{array}{l} H_2N.CHCOH \\ \quad\quad | \\ \quad\quad CH_2COH \end{array}$, which, although not yet isolated would be an aldehyde of aspartic acid; and a further condensation of $\begin{array}{l} 3H_2NCH.COH \\ \quad\quad | \\ \quad\quad CH_2.COH \end{array}$, to $C_{12}H_{17}N_3O_4$, and this again under the reducing action of sulphur to $C_{72}H_{112}N_{18}SO_{22}$, two molecules of water being eliminated at each condensation. To prove the presence of an aldehyde group in living cells the reducing power of that body on solutions of salts of several easily reducible metals was examined in detail. The most reliable and rapid indication of the existence of aldehyde groups was found to be a very dilute silver solution. This reagent was decided upon after a very thorough examination of a number of other metallic salts with aldehyde and other carbon compounds. The experiments with cell substance or protoplasm of Algæ, &c., show that during the period of "living" the silver salt is always reduced to metal, but that when by any means heating or drying by the action of salts, &c.—which exert a dehydrating or antiseptic action by which the "life" of the plant is destroyed—the reducing action on silver salts is destroyed also. Some of the alkaloids afford a striking exception, the cell's substance yielding an equally distinct silver reaction before and after a week's treatment with one per cent. solution of strychnine, &c. The authors are of opinion that certain aldehyde groups exist in protoplasm, and that it is to the chemical energy of such groups that the "living properties" of the protoplasm are to be ascribed.

Between the Amazons and Andes; or, Ten Years of a Lady's Travels in the Pampas, Gran Chaco, Paraguay, and Matto Grosso. By Mrs. M. G. Mulhall. (London: Edward Stanford, 1881.)

THE regions traversed by Mrs. Mulhall have always had a great fascination for the traveller, and though a good deal has been done of late years towards obtaining an exact knowledge of these remote parts of the world, still there are vast tracts of country between the Andes and the Atlantic, which offer virgin fields for geographical research.

From Buenos Ayres to Cordoba, to Mendoza, and beyond the latter as far as the Inca's Bridge, with an excursion by sea to Rio Grande, and back by land by way of Villa de Melo, not to count sundry short excursions, constitutes a tour extending over several thousands of miles, that required all the courage and determination of an Englishwoman to accomplish, as Mrs. Mulhall has done, successfully; and this record of her visit to the ruined shrines of the Jesuit missions, to the hunting-grounds of several native tribes, to the little-trodden forests of the Amazons, and to the slopes of the Andes, will be read with interest and profit.

Mrs. Mulhall's account of the plague at Buenos Ayres in 1870 is most graphic: the destruction was fearful, the city losing 26,000 souls. The natural history notes are not numerous; now and then, however, some facts of interest are mentioned. On the line of the San Louis Railway the ostriches are so numerous as to cause much trouble; for whenever a workman left any bolt or screw out of his hand, were it only for a moment, they disappeared, being swallowed up by these birds, and one of the engineers declared that they even went so far as to pick the bolts out of the iron bridges if they were left by chance unriveted!

At Corrientes, the house of a friend of Bonpland, the botanist and companion of Humboldt, was visited, and Mrs. Mulhall gives us an extract from a manuscript in Bonpland's handwriting which begins: "I was born at Rochelle on August 29, 1773. My real name was Amadé Goujaud. My father—a physician—intended me for the same profession. It was on account of my great love for plants that he gave me the sobriquet of Bon-plant, which I afterwards adopted instead of my family name."

At Lomas a farmer's wife gave the authoress a sample of white silk made by a large harmless gregarious spider. The silk appeared suitable for weaving, and a pair of stockings made from it are said to have been sent as a present to the King of Spain.

As an appendix to the second volume there is a history of the rise and fall of the Jesuit Missions in South America. The rise of these Missions marked a period of great prosperity. During the seventeenth and eighteenth centuries they were a theme of admiration among the writers and statesmen of Europe. To-day the traveller sees but the ruins of splendid churches that were built during that time, and the remains of some native sculpture and wood carving.

Geometrical Exercises for Beginners. By Samuel Constable. (London: Macmillan, 1882.)

THE title of this book seems to us hardly to hit the object for which it is really adapted. Exercises for

beginners we should expect to be confined to the very simplest deductions, and these should be most carefully graduated, whereas the exercises before us do not seem to be arranged in any very clearly-defined order. For instance, at one time we are in the first book, in the next question in the sixth book, and then back to the third, and so on. The references are apparently to Euclid, but not to editions in use in this country, as our author inserts on pp. 118, 120, 121, propositions which figure as Euc. vi. B, C, D, in Simson's text; on p. 126 a solution is given from Lardiner's (*sic*) Euclid.

The solution on p. 112 strikes us as not being the neatest that can be given of the exercise, and the figures on pp. 109, 110 are a little wrong. Having had our grumble, we must now say that we think Mr. Constable has produced a very fair book, with neat solutions and good figures, but we do not consider such a book called for. Every mathematical master has such a collection either in manuscript or ready for *vivâ voce* teaching, and has the more advanced works of McDowell and Casey on his shelves We can, however, suggest that the little book may be of use in preparation for University Local, and other examinations, though we do not see its suitability for *beginners*.

Algebra. Part II. By E. J. Gross, M.A. Second Edition. (London: Rivington, 1882.)

We are glad to see that this work has been so appreciated, that a second edition has been called for. The main defect of the first edition, in our opinion, was the plentiful crop of errata. This volume, we notice, has not been at all altered in the text, but very many of the errors have been corrected: we wish we could say that all errors had been removed, but this is not so. There are one or two curious slips: thus, for instance, in the Answers, p. 313, a correction is retained from the earlier edition, whilst the indicated alteration has been made in the text. Barring the errata, we again confidently commend Mr. Gross's book.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Pronunciation of Deaf Mutes who have been Taught to Speak

The conclusions arrived at by M. Hément (*Comptes Rendus*, xciii. pp. 754, 861, 1095) and Mr. Axon (Nature, vol. xxv. pp. 101, 409; *Comptes Rendus*, xciii. p. 904) concerning the influence of heredity upon the speech of the deaf cannot be accepted unless it can be shown that the peculiarities of utterance to which they have directed attention *could not have arisen in the ordinary way by imitation of the speech of others*.

Before we can decide whether any observed peculiarity in the utterance of a deaf person is due to inheritance or to imitation, we must know (1) at what age he became deaf; (2) whether the deafness was total or partial; and (3) whether, since the acquisition of speech by the sense of sight, the deaf subject has associated with persons who speak with the accent of his native district.

The remarks of M. Hément are valuable as the result of personal observations, but he has failed to be explicit upon these important points.

The cases referred to by Mr. Axon are equally inconclusive for the following reasons:—

1. In the first case noted (Nature, vol. xxv. p. 101)—which is also the one to which Mr. Axon directs special attention in his recent letter to Nature, vol. xxv. p. 409—we have a case of undoubted imitation through the sense of hearing.

Indeed it is stated in the *Phil. Trans.* No. 312, that some weeks after recovery from an illness, this young man (Daniel Fraser) "began to *hear* and in process of time to understand speech. This naturally disposed him to *imitate* what he heard and to attempt to speak."

The account from which this is quoted, is evidently intended simply as a record of a case of recovery of hearing in a deaf mute, with subsequent acquisition of speech; and Mr. Axon himself admits that the writer mentions the inheritance of the Highland accent "in a purely incidental manner."

With due deference to Mr. Axon's opinion, it appears to me that this is not a case in point, and that it is not entitled to the same consideration as that of a person who, remaining deaf, acquired speech through the sense of sight, and has no opportunity of imitating by ear the pronunciation of others. It must also be remembered that this case is quoted from an old number of the *Phil. Trans.*, and cannot now be verified.

2. The circumstances quoted from the "Life and Journals of George Ticknor" (Nature, vol. xxv. p. 101) are unreliable, because Ticknor *assumed* that all the pupils in the deaf and dumb schools he examined could never have heard a human sound,[1] whereas it is now known that a very large proportion of the deaf and dumb (probably more than 50 per cent.) could hear in infancy, and that of these a large proportion could also speak before becoming deaf.

3. In regard to the case of "E. R.," who had been taught articulation by Mr. Alley, of Manchester, Mr. Axon says, "that he became deaf and dumb *at a very early age*" (Nature, vol. xxv. p. 191), but neglects to state at what age, which is very important—nor had Mr. Axon himself heard the articulation of this young man.

These are all the instances I know of, in which it is claimed that the pronunciation of any deaf person was due to inheritance, and I think I have shown that in all these cases the necessary data for such a conclusion have been wanting. I have already stated in a former communication (Nature, vol. xxv. p. 124, *Comptes rendus*, xciii. p. 1036) that I have examined the pronunciation of at least 400 deaf children who have been taught to speak, without finding a single instance of peculiarity that could correctly be attributed to heredity. If any further argument is needed against inheritance of pronunciation, it is to be found in the universal fact that children who are born deaf are *always also dumb*.

That there is no incapacity of the vocal organs to account for this is evident, for these so called "deaf-mutes" are now taught, through the medium of the sense of sight, to control the movements of their vocal organs so as to give utterance to intelligible words.

When we examine the languages and dialects of the world, I think we find that they have something in common, while each retain distinctive characteristics of its own. There seems to be a universal tendency to express the *emotions* in the same way. We speak, in fact, two languages at the same time:—One—the language of thought—arbitrary and conventional, acquired by imitation and not hereditary, consisting of articulations constituting words and sentences which can be recorded and preserved in written books; the other—the language of the emotions—natural and universal, consisting of looks and gestures, and of intonations of the voice. There seems good reason for the belief that this natural language of the emotions is instinctive, and therefore hereditary. From my own personal observations I feel sure that those who are interested in questions of heredity will find a rich field for inquiry in the study of the facial expressions and gestures of very young blind children; and in the natural sounds and the modulations of the voice of deaf infants.

Rome, March 6 Alexander Graham Bell

In his letter on the above subject in Nature (vol. xxv. p. 409) Mr. Axon appears not to appreciate the value of negative testimony in scientific investigation.

The citation of cases in support of M. Hément's statement that deaf mutes who have been taught to speak do so with the accent of their native districts, obviously implies the promulgation of a theory that dialectal accent is due to physiological peculiarities (? of the verbal organs), and that these are hereditary. This is shown by the objections raised to Prof. Graham Bell's statement that all such phenomena are due to "the unconscious recollection of former speech, and cannot be

[1] "Not one of the pupils *of course* can ever have heard a human sound," &c. "Life and Journals of George Ticknor." London, 1876. Vol. I. p. 196.

attributed to heredity." Now in order to be admissible, a theory must harmonise with all the phenomena. It is an admitted axiom in science that even one "negative" case is all but fatal to a theory. Dreams occasionally "come true," and persons who have been impressed by such coincidences base on them a belief in ghosts. But the great majority of dreams do *not* come true, and therefore science does not recognise the existence of ghosts. Careful investigation may bring out many explanations of a few cases of deaf "mutes" apparently speaking with the accent of their native districts, without attributing the phenomena to heredity. But if dialectal accent is hereditary, how are we to explain the 400 cases cited by Prof. Bell (to name one competent observer alone) in which no such accent was observable?

Mr. Axon quotes (apparently with approval) M. Hément's declaration of inability to conceive "how in losing the use of speech, deaf mutes should retain the unconscious memory of accent." I wish to suggest that such phenomena may be due to automatic activity of the cerebral tissue. In his last "Causerie," in the *Rappel*, M. Victor Meunier mentions the case of a young man, an inmate of a French asylum, who six years ago became deaf with the right ear through the effects of typhoid fever. He is occasionally conscious of sounds on the right, or deaf side, of which the left ear gives no indication whatever. He hears entire sentences, distinctly articulated, and as these are sometimes of an offensive character, they have involved him in many quarrels, as he has attributed them to perfectly innocent persons who have chanced to be near his right side at the time. Notwithstanding this hallucination, his judgment has remained sound, and having discovered that he sometimes hears (with his right ear) absent or stopped clocks strike loudly, he has learned to disregard any sounds but those which his left ear communicates to him. M. Luys, of the hospital of La Salpêtrière, gives many illustrations of such automatic activity.

Remembering that memory has a physiological basis, and believing in the psychical basis of language, I find it far less difficult to conceive that after the loss of speech deaf mutes should retain the "unconscious memory" of accent than that accent should be hereditary. Indeed the loss of speech might even be favourable to such retention; for the particular cells concerned might keep the original impression unimpaired by subsequent impressions, to be accurately given forth again when the requisite conditions came into operation.

This does not explain the case of Daniel Fraser, said to have been mute from his birth; but, on the other hand, "one swallow does not make a summer." F. J. FARADAY

Manchester, March 4

Vignettes from Nature

WITH all due deference to Dr. Carpenter, for whose supreme authority on all matters of biological fact I have, of course, the profoundest respect, I must plead that he evidently has not looked into my little book, "Vignettes from Nature," but has taken his statements at second hand from the necessarily condensed account given in Mr. Wallace's kind review. Had he consulted the book itself, he would have found most of my remarks intentionally so guarded as to escape his strictures.

First, as to the sharks. Dr. Carpenter says, "None of these, in the judgment of Mr. Grant Allen and Mr. Wallace, surpassed the forty-feet sharks of the present time"; and he goes on to speak of a *Carcharodon* tooth from the Crag, 4 inches long by 3 broad. Now, in "Vignettes," p. 76, I wrote, "The teeth of what seems to have been the biggest known fish, a prodigious shark, are dredged up in the modern ooze of the Pacific. . . . They have become extinct at a very late date." I took my facts from Dr. Günther's "Study of Fishes," p. 321, where we read as follows:—"*Carcharodon* teeth are of very common occurrence in various tertiary strata. . . . Some individuals attained to an immense size, as we may judge from teeth found in the Crag, which are 4 inches wide at the base, and 5 inches long. . . . The naturalists of the *Challenger* expedition have made the highly interesting discovery that teeth of similar size are of common occurrence in the ooze of the Pacific, between Polynesia and the west coast of America. . . . The gigantic species to which these teeth belonged must have become extinct within a comparatively recent period." In short, the very shark which Dr. Carpenter claims as tertiary, I had previously claimed as also nearly modern.

Dr. Carpenter further says, "Is it clear that *Tridacna* is the largest known Mollusk? I should have thought it exceeded by the gigantic *Ammonitidæ*, &c." But if he will turn to "Vignettes," p. 75, he will see that I wrote, "No fossil *bivalve* molluscs to my knowledge are as big as . . . tridacna." The word I have italicised makes all the difference. On p. 77 Dr. Carpenter will see that allusion is made to the big Cephalopods, though perhaps none of these were very much larger than the largest modern gigantic squids.

As to the other points, they are really matters of language, and I will not take up your space by answering them in detail. When I spoke of "our whales," I certainly did not mean to exclude extinct whales: I merely meant to contrast them with the great secondary Saurians. Nor did I say that horses, elephants, &c., had been steadily increasing in size from "the earliest epoch of their appearance to the present day"; I said, "to the recent period," which is quite another thing. As I was writing for popular readers, not for biological critics like Dr. Carpenter, I felt bound to use the vague but comprehensible language of ordinary life; and so I described the mammoth as "recent," quite justifiably, I think, for my existing purpose. No technical words were used in the volume, and it was impossible always to find popular ones quite free from objection. But if Dr. Carpenter will kindly read the short chapter in question, I venture to think he will be willing to withdraw his present strictures. The object was merely to combat the vulgar notion that all the animals of all geological ages were positively gigantic; and in doing so, almost every animal mentioned by Dr. Carpenter was expressly adduced as an example.

In answer to ΦΠ, I should like to add that I used the word "accidental" in a strictly Pickwickian sense.

GRANT ALLEN

Miss Cobbe and Vivisection

WILL you allow me as one not only ardently interested in the pursuit of vivisection as a means of extending our knowledge, but also as a sincere hater of unnecessary cruelty to animals, to state the following facts which I know to be true:—

Some little time ago Miss Frances Power Cobbe, who has so identified herself with the cause of anti-vivisection, called on a distinguished man of science to endeavour, by persuasive speech and *vivâ-voce* argument, to gain him over to her cause. Three points were observable in Miss Cobbe's outward presentment, viz.: she had an ostrich feather in her bonnet; a bird of paradise in, on, or near her muff; and she carried an ivory-handled umbrella; consequently the distinguished man of science replied as follows:—

"Madam, charity begins at home; when you have given up wearing *ostrich feathers*, which are plucked from the *living bird*, causing the most exquisite pain, and birds of paradise, which, in order to enhance their beauty and lustre, are *skinned alive*; when you have abjured the use of *ivory*, because you know that the tusks are *cut out* of the dying elephant's jaw, then, and then only, come and upbraid me with the cruelty of my operations. The difference between us is, Madam, that *I* inflict pain in the pursuit of knowledge, and for the ultimate benefit of my fellow-creatures; *you* cause cruelty to be inflicted merely for your personal adornment . . ." H. H. JOHNSTON

Zoological Gardens, Tuesday

The Electrical Resistance of Carbon under Pressure

FROM the abstract of the proceedings of the Physical Society, given in NATURE, vol. xxv. p. 426, I learn that Prof. S. Thompson has been making some experiments which tend to show that the observed diminution of the resistance of carbon under pressure in such instruments as the carbon relay, rheostat, and microphone-transmitter is really due to the contact between the electrodes and the carbon. No doubt the greater portion of the observed diminution of resistance is due to this cause, and I have already pointed out in my paper on "the Influence of Stress and Strain on the Action of Physical Forces," Part ii., Electrical Conductivity, an abstract of which (NATURE, vol. xxv. p. 401) was read before the Royal Society on January 26, that the effect of a given amount of longitudinal traction or compression per unit area on the electrical resistance of some carbon rods was not greater than is the case with the metals tin and lead, for whereas a stress of 1 gramme per sq. cm. produced a variation of conductivity of from 7684×10^{-12} to 11420×10^{-12} per unit in the case of five carbon rods, the corresponding numbers were, with tin and lead, 10540×10^{-12} and 17310×10^{-12} respectively. The carbon rods were of the sort used for the purposes of electric

lighting, and their elasticity varied in almost the same proportion as their susceptibility to change of resistance from stress, so that, the alteration of resistance divided by the strain produced, ranged in the five specimens between the limits 2·144 and 2·835. The corresponding numbers in the case of most pure metals (aluminium is an exception) are *greater* than these, and in the case of nickel, with which metal curiously enough the effect of moderate longitudinal traction is to *decrease* the resistance, the alteration of conductivity is *much* greater.

It will be observed from the numbers given above that the diminution of resistance which can be produced in carbon by pressure is very slight, so much so indeed that if we could compress a carbon rod to *half* its original length, the resistance would not be diminished to one-third of the original resistance, and that therefore the amount of compression which can be really produced without danger of breakage causes such a slight decrease of resistance as requires special precautions and a good galvanometer if this decrease is to be measured with any accuracy.

King's College, Strand, March 7 HERBERT TOMLINSON

Palæolithic Floors

IN reference to this subject, as adverted to by Mr. W. J. Knowles, NATURE, vol. xxv. p. 409,—several Palæolithic working-places, floors, or old land surfaces have been described. With some of these surfaces, I am slightly acquainted, and with one of them I am *well* acquainted, as it was discovered by myself in London, in 1877–8. This surface is in the Valley of the Hackney Brook, an affluent of the Lea, which in its turn is a northern tributary of the Thames. The course of the Hackney Brook is illustrated in the No. of NATURE (p. 417) which contains Mr. Knowles' letter; when excavations are made in this valley, Palæolithic implements and flakes are disinterred, which in some instances belong to the Thames and are very ancient, in others to the Lea and probably somewhat less ancient, whilst a third set of implements belong to the Hackney Brook, and undoubtedly date from a very recent period of the Palæolithic age. In the surface humus of the Lea near the Hackney Brook, Neolithic celts, polished and unpolished are also found with flakes of the same age.

When I first found Palæolithic implements in the gravel, sands and loam of north-east London, I was greatly puzzled by some of the examples being considerably abraded, whilst others were as sharp as if just made. The sharp examples belong to one stratum and the abraded specimens to a totally different one. The explanation of the abraded and unabraded examples rests in the fact that near the Hackney Brook most of the gravel is about ten or twelve feet below the surface, but this Thames gravel and its contained abraded implements has nothing whatever to do with the Hackney Brook, the old banks of which are about four or five feet below the present surface, and on these banks (which I have examined in the stream's course for three quarters of a mile, north and south at Stoke Newington, and Shacklewell) there lived at one time a considerable colony of Palæolithic men. The floor upon which this colony of men lived and made their implements has remained undisturbed till modern times and the tools, together with thousands of flakes, all as sharp as knives, still rest on the old bank of the brook just as they were left in Palæolithic times. In some places the tools are covered with sand, but usually with four or five feet of brick-earth; the sand when it occurs is full of the shells of fresh-water molluscs.

The floor is exposed in digging for the foundations of houses, it is sometimes visible as a dark line only at the base of the loam; at other times by the presence of a few inches of gravel; occasionally the traces of the floor are obliterated. All the implements from this floor are as sharp as on the day they were made, a few are dull in colour, the majority are lustrous, a few are whitish from their long contact with clay, but though the surface of the implements is whitened by decomposition, yet the tools remain perfectly sharp. As a rule the implements of the Hackney Brook are small in size, beautifully made, and extremely neat, some rivalling in exquisite workmanship the best Neolithic work: scrapers are fairly common, but not of the horse-shoe form. Were the makers of these tools the same with the men of some of the caves? the evidence seems to point in that direction. "Cave-men" could not always have been in caves, surely some of these "Cave-men" lived in communities in the open air, and it seems clear that if we are to find intermediate links between Palæolithic and Neolithic times we must not confine ourselves to caves but search for traces in positions like the comparatively modern Valley of the Hackney Brook.

It appears to me that these minor tributaries of great rivers have never been properly searched. Geologically considered, the Thames with its gravel and implements must be extremely ancient, whilst the shallow unimportant Hackney Brook must be comparatively modern. In these minor affluents then we have traces of the more recent cohorts of Palæolithic men, and the tools that are found, seem, by their style of workmanship, to prove their comparatively recent date.—Recent as that date may be however, I consider it to be far older than the times when the lower terraces of the Thames were laid down, for in these lower gravels, implements and flakes (with the exception of some stray example now and then, that has been washed down from a higher position) are absent.

Any person is at liberty to look over the things I have got from this place, but at present I do not wish for the number of the tools to be further reduced by gifts or exchanges. Many objects I have already given away, but, for a time, at any rate, I wish to *keep the things together*, as they teach a better lesson *in company* than when distributed in different collections. As for the simple flakes, whether sharp and belonging to the till now undisturbed Palæolithic floor of the Hackney Brook, or abraded and belonging to the deeper excavations exposing the old terrace of the Thames, any one is welcome to any number of examples of these from me, and I am willing to send them as gifts to anyone, provided I am not put to expense in transit.

At the present time the Palæolithic floor is to be seen in section in several places, and I will conclude by mentioning one. On the north side of Stoke Newington Common, (nearest point, Stoke Newington Railway Station, from Liverpool Street) there are four new roads; the easternmost road is named Fountayne Road, and is marked on Stanford's Library Map of London. At the extreme south end of Fountayne Road, *i.e.* the Stoke Newington Common end, on the east side, shallow foundations of about four feet have been dug for a few new villas; now, if the two or three northernmost of these shallow excavations are looked into at a depth of about three feet, a thin stratum of gravel, a few inches only in thickness, will be seen sloping southwards into the (here filled in) Hackney Brook. This is the floor upon which the Palæolithic men once walked, lived, and made their tools. In the excavation for the two northernmost villas I recently saw the loam carefully removed, and on this spot two pointed Palæolithic implements (one amongst the best of my collection) were found, the first black and lustrous, the other buff, mottled with white from long contact with the loam, and lustrous, both as sharp as knives; they were picked up with numerous flakes on the very spot where they were originally laid down by their Palæolithic owner or owners.

A word of warning to visitors. After I published my localities in 1868, certain persons went to the places mentioned, and offered large sums of money to the men for implements and flakes; in this case, the unfortunate result was, that the men and boys of this spot soon found that they could strike off flakes and even make implements sufficiently near to deceive "avid but unwary collectors." Therefore, unless any visitor instantly knows at sight (which is quite easy) a genuine implement or flake from one made on the spot, let him buy nothing of the boys or men without first consulting the writer of this note.

WORTHINGTON GEO. SMITH

125, Grosvenor Road, Highbury, N.

The Advance of Norwegian Glaciers

IN NATURE, vol. xxv. p. 449, you quote an account from *Naturen* of the changes of movement observed in Norwegian glaciers. In this it is stated that the great Folgefond glacier, near the Sörfjörd, a branch of the Hardanger, has had alternation of advance and retreat, but that it advanced 40 metres between 1860 and 1878. This, no doubt, is an account of the very remarkable advance of the Buerbræ (bræ is Norsk for glacier) near Odde, on the Sörfjörd. I visited the place in 1874, and the recent ploughing up of a considerable bit of the valley by the vast irresistible ice-plough was very striking, while the glacier itself was very beautiful. My object, however, is to repeat a strange piece of folk-lore, which tends to show that in this particular spot, the advance of the glacier must have been long-continued. The legend was told me by Asbjörn Olsen, a very intelligent guide at Odde, who speaks good English. The tale was that long ago the Buer valley extended far into the mountains, and was full of farms and cultivation. It had also a

village, a church, and a pastor. One winter night when a fearful storm was threatened, three Finns (*i.e.* Lapps) entered the valley and begged shelter in vain of the inhabitants. At last they asked the priest, and he too refused. Then the wrath of the heathen wizards was raised, and they solemnly cursed the valley and doomed it to destruction by the crawling power of the ice, until the glacier reached the lake below. The Lapps were seen no more, but on their disappearing the snow began to fall. The winter was awful. The glacier approached by awful steps, and by degrees engulfed the cursed valley and farms. Nor is the curse yet exhausted, for the glacier creeps down the valley each year, and has yet a mile to go before it reaches its destination in the lake above Odde. I am no judge of folk-lore, but this weird tale seemed to me a genuine piece of it, and not invented for the occasion, as Olsen gave it half jokingly as the tradition of the district. The farmer who owns the remnant of the doomed valley, wanted then to sell it, as he saw his acres swallowed up each year, but no one will buy. If this tale be genuine, it points to a prolonged advance of the Folgefond, which has led to the tale of the Lapps' curse. Those interested in ice-action will see a fine example of the "Tyssenstrengene," or polished stone fells of Norway, between Odde and the splendid Skjægadals (or Ringedal's) Fos. The rocks are so polished by the ancient ice that a path is made over them by putting rough fir trees down to give a foothold. The ice-polishing on the Grimsel Pass in Switzerland, is a mere nothing to these "Tyssenstrengene."

J. INNES ROGERS

Intelligence in Birds

OUR English jackdaws are not behind Miss Bird's Japanese crows in at any rate one of the instances of intelligence told by her. Many years ago it was a frequent amusement of ours to watch the encounters between a tame jackdaw and the stable cat. The cat's dinner used to be put down outside the stable-door, and, warned by experience, she hastened to dispose of as much as possible before the arrival of the jackdaw. He seldom went directly to the meat in the plate, but attacked the enemy in the rear, settling himself with both feet on her outstretched tail to steady it, and then administering pickaxe blows on it with his beak. Of course it was impossible to stand this, and with a forcible exclamation the cat used to spring away, and Jack took possession of the plate, until our sense of justice obliged us to recall and defend the rightful owner.

E. HUBBARD

March 6

Auroral Display

I SEE by your number of NATURE, vol. xxv. p. 386, that an auroral display was witnessed in England on February 20, between 7 and 8 p.m. A very magnificent one was seen in the Hardanger-fjord on the same evening at the same hour, by a friend of mine, and the Captain of the ss. *Folgefonden* says he has never seen a finer. Could it have been the same aurora?

W. E. KOCH

Lysefjord near Stavanger, Norway, March 9

ON THE CHEMISTRY OF THE PLANTÉ AND FAURE ACCUMULATORS

PART II.—*The Charging of the Cell*

IN NATURE (vol. xxv. p. 221) we directed attention principally to the local action that takes place on the negative plate of a Planté or Faure battery. We pointed out the close analogy between zinc coated with spongy copper, and lead coated with spongy peroxide, in their action on water or dilute sulphuric acid; and we showed the importance of the lead sulphate produced in moderating this action. We now propose to treat of the chemical changes involved in the preparation of the cells.

The procedure of Planté in forming his battery is at first sight extremely simple. He takes two coils of lead, separated from one another, and immersed in dilute sulphuric acid; a current is sent through the liquid from one lead plate to the other, and the final result is, that the one becomes covered with a coating of lead peroxide, while hydrogen is given off against the other plate. On the view that the sulphuric acid merely serves to diminish the resistance, and so facilitate the electrolysis of water, the ready explanation would be given that the two elements of the water are simply separated at the two poles. But it seems more in accordance with the facts of electrolysis, to suppose that the sulphuric acid, H_2SO_4, is itself the electrolyte, and that the oxygen results from a secondary chemical reaction. As a matter of fact, if water be employed, no peroxide is formed, but only the hydrated protoxide, even though a current from twenty-four Grove's cells be made use of. The addition of a single drop of sulphuric acid to the water is enough to cause the immediate production of the puce-coloured oxide.

If we take two plates of lead in dilute sulphuric acid, and pass the current from only one Grove's cell, a film of white sulphate, instead of peroxide, makes its appearance on the positive pole, and the action practically ceases very soon. If, however, the current be increased in strength, the sulphate disappears, and peroxide is found in its place. In Planté's procedure, spongy lead, and lead peroxide are indeed found on the respective plates. But, in consequence of the local action which takes place during the periods of repose, lead sulphate will be produced from the peroxide, and afterwards, in the course of the "formation," this must be reduced to metallic lead by the hydrogen.

It may seem at first sight improbable that an almost insoluble salt of the character of lead-sulphate should be decomposed under these circumstances. To test this fact by direct experiment, we covered two platinum plates with lead-sulphate, immersed them in dilute sulphuric acid, and sent a current through. We found not only that the sulphate was reduced by electrolytic hydrogen, but that it was peroxidised by electrolytic oxygen. The white sulphate was, in fact, decomposed to a large extent at each plate, the positive being covered with deep chocolate-coloured peroxide, the negative with grey spongy lead.

The reaction which takes place in charging a Planté battery may be viewed in two ways. The simplest may be thus expressed in the notation which we have employed in some previous papers. For convenience, the reaction is divided into two stages:—

$$Pb_x \left| \begin{array}{c} SO_4H_2 \\ SO_4H_2 \end{array} \right| Pb_y = Pb_{x-1} \mid PbO_2 \left| \begin{array}{c} SO_3 \\ SO_3 \end{array} \right| \begin{array}{c} H_2 \\ H_2 \end{array} \Big| Pb_y.$$

and $$2SO_3 + 2H_2O = 2H_2SO_4.$$

But it may be that lead-sulphate is always formed in the first instance, and decomposed on the continuation of the current.

$$Pb_x \mid SO_4H_2 \mid Pb_y = Pb_{x-1} \mid SO_4Pb \mid H_2 \mid Pb_y.$$

then

$$Pb_{x-1} \mid SO_4Pb \mid SO_4H_2 \mid Pb_y = Pb_{x-1} \mid PbO_2 \left| \begin{array}{c} SO_3 \\ SO_3 \end{array} \right| H_2 \mid Pb_y.$$

and $$2SO_3 + 2H_2O = 2H_2SO_4.$$

It seems not improbable that both these reactions may take place according to the varying density, or other circumstances of the current. The coating of peroxide interposes a great difficulty in the way of the further oxidation of the metallic lead. Hence Planté needs the successive periods of repose, to admit by local action of the formation of lead-sulphate, and the oxidation of the increasing amounts of finely-divided lead thus brought into the field of action.

To obviate this waste of power and time, Faure covers both plates with red lead, and converts this into spongy peroxide and spongy lead respectively by the current. Now the first thing that happens, when the plates are immersed in the dilute sulphuric acid is a purely chemical action. The minium suffers decomposition according to the formula—

$$Pb_3O_4 + 2H_2SO_4 = PbO_2 + 2PbSO_4 + 2H_2O.$$

But as both the lead sulphate and lead peroxide are insoluble, this takes place mainly at the surface, and requires time to penetrate. Thus in an experiment performed with the object of testing this point, the following amounts of minium were found to be converted into lead sulphate in successive periods of time.

Time.	Minium changed into sulphate.
15 minutes ...	11·8 per cent.
30 ,, ...	13·7 ,,
60 ,, ...	14·6 ,,
120 ,, ...	18·1 ,,

It might happen, and we are told it has happened, that the amount of minium employed has been great enough to abstract the sulphuric acid from solution, leaving only water. In that case water, of course, would be the electrolyte, and there can be little doubt that the lead plate would suffer oxidation in the manner which was described by us some years ago (*Chem. Soc. Journ.*, 1876) in a paper on "Phenomena accompanying the Electrolysis of Water with Oxidisable Electrodes." This paper detailed the results obtained on passing a current from one Grove's cell between two plates of the same metal immersed in pure water. We stated in the case of lead: "The positive electrode showed signs of slight oxidation, and the negative electrode a few small bubbles, in fifteen minutes; a slight cloudiness was then beginning to form, which afterwards increased; some oxide was found adhering in an hour; and afterwards grey metallic lead, which at the end of twenty-two hours was found to have stretched across to the positive electrode, forming a metallic connection which was so much heated by the passage of the voltaic current that the liquid became warm." We are informed that such lead crystals have sometimes been found in Faure's cells.

Supposing, however, that there is enough and to spare of sulphuric acid, the mixture of lead peroxide and lead sulphate presents a double problem. Were we dealing with peroxide alone, it would be reduced on the one plate at the expense of two molecules of water or sulphuric acid, while at the opposite pole the oxygen would simply be liberated.

$$\mathrm{Pb} \mid \mathrm{PbO_2} \mid \mathrm{SO_4H_2} \mid \mathrm{SO_4H_2} \mid \mathrm{PbO_2} \mid \mathrm{Pb}y = \mathrm{Pb}x \mid \mathrm{PbO_2} \mid \mathrm{O_2} \mid \mathrm{SO_4H_2} \mid \mathrm{SO_4H_2} \mid \mathrm{Pb}_{y+1}.$$

But as there is always lead sulphate present, this liberated oxygen is mainly used up in oxidating that substance, and it is evident from the following formula that it is theoretically sufficient to peroxidise the two molecules of sulphate—

$$2\mathrm{PbSO_4} + 2\mathrm{H_2O} + \mathrm{O_2} = 2\mathrm{PbO_2} + 2\mathrm{H_2SO_4}.$$

These two molecules of $PbSO_4$ are obtained from one molecule of Pb_3O_4 (red lead), and it appears that two atoms of oxygen are sufficient to transform this into peroxide. But the corresponding amount of hydrogen (four atoms) by no means suffices to reduce a similar amount of red lead on the other side, for in this case both the peroxide and the sulphate formed by the action of the acid have to be reduced. To accomplish this at least eight atoms of hydrogen will be necessary, and this will demand the electrolysis of an additional two molecules of water or sulphuric acid. It might therefore be expected, *a priori*, that the minium on the side to be oxidated ought to be twice the amount of that to be reduced.

In order to ascertain what is the real course of procedure, in charging a Faure battery, we took two plates of lead of equal size, and covered each with a known weight of minium, which was almost pure Pb_3O_4. We passed a current of known strength, about one Ampère, through the arrangement for many hours, noting the amount of hydrogen gas which was liberated at the one pole, and the amount of oxygen liberated at the other. From the data it was easy to calculate the amount of electrolytic hydrogen and oxygen utilised. We performed the experiment several times, varying the strength of the current and some other circumstances. The most complete result was as follows:—

Time.	Hydrogen.		Oxygen.	
	Lost.	Absorbed.	Lost.	Absorbed.
hours.	c.c.	c.c.	c.c.	c.c.
1	Nil	312	Nil	156
2	"	318	18	141
3	"	306	48	105
4	"	300	66	84
5	"	300	72	78
6	2	313	90	67
7	5	295	87	63
8	3	312	96	61
9	6	303	93	61
10	21	297	99	60
11	37	273	99	56
12	101	220	105	56
13	150	158	105	49
14	195	132	105	58
15	210	92	100	51
16	228	90	106	53
17	225	85	100	55
18	270	66	108	60
19	264	51	108	49
20	270	50	111	49
21	273	43	114	44
22	270	30	114	36
23	276	30	114	39
24	297	21	123	36
25	309	9	126	33
26	270	18	120	24
27	300	18	132	27
28	309	11	138	22
29	321	15	141	27
30	318	15	147	19
31	300	6	135	18
	5230	4489	3120	1737

The amounts of hydrogen and oxygen capable of being absorbed by the materials on the plates were 4574 and 1294 respectively.

We read the indications of this table in the following way:—At first, both the reduction and oxidation take place very perfectly, with little loss of either of the elements of water. The absorption of the hydrogen proceeds with little diminution, until by far the greater part of the lead peroxide and sulphate are reduced, but the last portions are very slowly attacked, probably because they are imbedded in a mass of reduced lead. On the side that is being oxidated it is otherwise: a considerable waste of oxygen soon shows itself, but nevertheless a continuous slow absorption of that element takes place long after the theoretical amount of it has been fixed. A very small amonnt of this excess is to be attributed, according to our experiments, to the oxidation of the metallic plate itself. But we attribute the greater portion to the local action which must be constantly going on between the peroxide and the lead plate with the formation of sulphate of lead, the sulphate in its turn of course being attacked by the electrolytic oxygen. Thus the excess of oxygen in the fifth column of the above table may be looked on as a measure of the local action which has taken place during the charging, and the figures in the lower portion as roughly indicating its progress from hour to hour. Local action will of course take place at first on the opposite plate, but it requires no more hydrogen to reduce two molecules of lead sulphate,

than one molecule of lead peroxide, and the possibility of local action gradually diminishes as the reduction proceeds.

All our other experiments told the same story as far as the absorption of hydrogen is concerned, but there are differences on the other plate. In one or two instances, not half of the theoretical amount of oxygen was absorbed. On searching into the circumstances on which this depended, we were unable to arrive at any other conclusion, than that it was connected with the condition of the surface of the lead plate.

Experiments with a current of about two Ampères showed that a larger quantity of both hydrogen and oxygen was fixed in a given time, but there was a larger proportionate loss, especially in the case of oxygen. Experiments with a current of about half an Ampère, on the contrary, gave a somewhat less rapid action, but a smaller waste of force through the escape of free gas.

A complete study of the results of these experiments would be instructive, but the following comparisons may suffice to illustrate the points just mentioned. The theoretical amount of oxygen required for the red lead used is about 1200 cc., and the table shows the length of time in which 300, 600, and 1000 cc. were fixed by different strengths of current, together with the accompanying loss.

Strength of current.	Amount of oxygen stored.	Time.	Loss of oxygen.
Ampères	c c.	hours.	c c.
2	300	1·5	174
1	,,	2	18
½	,,	3·8	15
2	600	4·1	617
1	,,	5 5	249
½	,,	7·6	47
2	1000	13·9	3081
1	,,	12·2	900
½	,,	16·0	400

In some cases we mixed the red lead with a little water, and allowed it to dry. In other experiments we mixed it at once with dilute sulphuric acid, but without any particular practical advantage.

The forming of a good secondary battery is a matter evidently depending upon very nice adjustment of conditions. It is but a few of these that we have carefully studied ; nevertheless we feel ourselves in a position to make one or two suggestions in regard to the economic aspects of the question. It is evident that the energy stored up in a cell is determined mainly by the amount of peroxide present. This appears to be obtained with the smallest amount of waste when the current is not too strong ; in fact, in our experiments it was obtained when the density of the current was about 6½ Ampères, calculated on the original surface of the lead plates.

There would seem to be no commensurate advantage in continuing the current after the oxygen has ceased to be absorbed pretty freely, because the presence of some unoxidised sulphate of lead, although it increases the resistance, rather impedes than promotes local action.

On the other hand, however, it is necessary that the reduction of the minium on the opposing plate should be complete, for a mixture of lead peroxide and metallic lead would be peculiarly conducive to the production of lead sulphate, and thus increase the resistance ; while if any peroxide should remain, it would diminish the electromotive force of the cell.

It would appear probable, therefore, that the most economical arrangement would be obtained by making the red lead to be hydrogenated much smaller in amount than that to be oxidated. On trying the experiment with only half the quantity, we obtained a most satisfactory result as far as the charging was concerned. How far such an arrangement may be really desirable we hope to consider more fully when we treat of the chemistry of the discharge.

J. H. GLADSTONE
ALFRED TRIBE

March 9

THE CHANNEL TUNNEL

THE two schemes for a tunnel beneath the Channel, on the comparative merits of which a Parliamentary Committee will probably take evidence in the course of the year, are based, like those which have preceded them, chiefly on geological considerations. The Weald of Kent and the Bas-Boulonnais, once in all probability geographically continuous, still constitute a single geological area. The chalk of Calais and Sangatte forms the prolongation of that long range which, striking through Dover, Rochester, and Guildford, to near Basingstoke, is known as the North Downs; while that which strikes the coast south of Boulogne, is continued in Beachy Head, and the long range of the South Downs. The North and South Downs curve gently round, so as to meet towards the west, and similarly the Bas Boulonnais is inclosed by the meeting of the two ranges on the French coast towards the east.

In both these districts the beds of the chalk dip away from the inclosed area, generally at a gentle angle as at Dover, but sometimes steeply as in the Hog's Back. It is clear from this that the beds which rise to the surface in the Weald and in the Bas-Boulonnais are geologically older than the chalk, and must pass under it laterally. The escarpments of the chalk may thus be compared to the fragmentary walls of an oval dome, the top of which has decayed away. The longer axis of this dome extended approximately east and west.

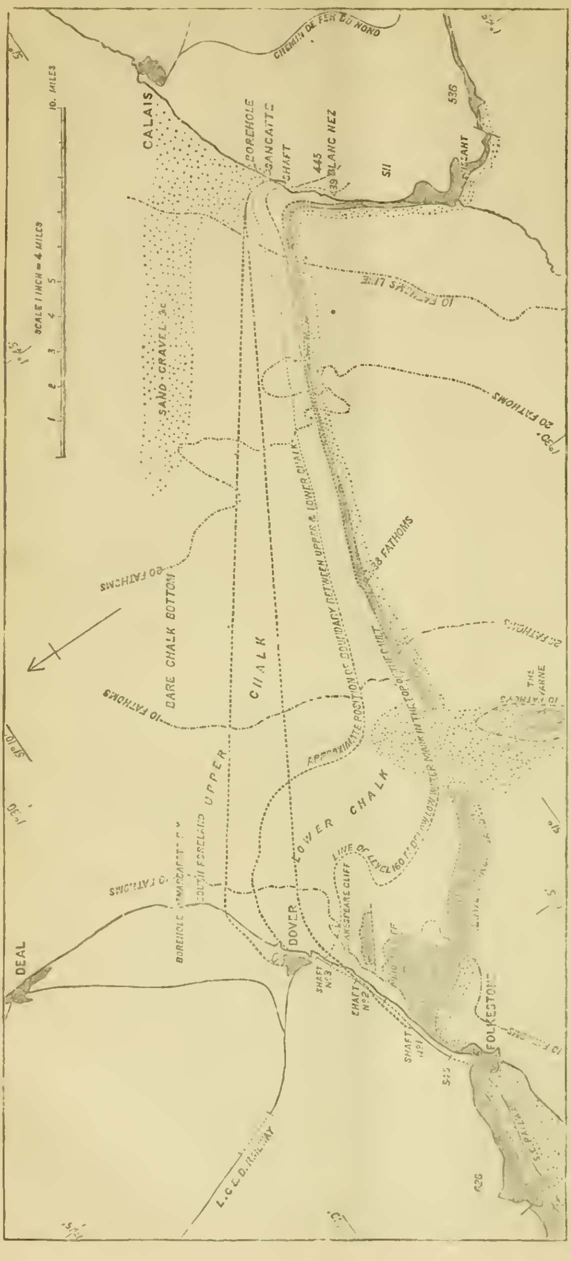
The sequence of beds from the chalk downwards is as follows [1] :—

		English Coast. feet.	Bas-Boulonnais. feet.
Upper	Chalk with flints	350	
	Chalk with few flints	130	
Lower	Compact nodular without flints	90	... 130
	Chalk without flints	50	
	Grey Chalk	200	... 180
Upper Greensand		0–12	... 0–3
Gault		100	... 30–36
Lower Greensand		250	... 12½
Wealden Beds	Weald Clay 350; Hastings Beds 800	1150	... 100 ?
Purbeck Beds		400	
Portland Beds		80	Sub-Wealden Boring [2]
Kimmeridge Clay		1070	Sub-Wealden Boring [2]
Coralline Oolite		550	Sub-Wealden Boring [2]
Oxford Clay		60	Sub-Wealden Boring [2]

Of these formations the Chalk and Gault have been proved to run with remarkable persistency over a very large area, changing in thickness slowly and uniformly in ascertained directions. It thus was a matter of the utmost probability that they would be found occupying their proper position relative to the other formations, and of their usual dimensions, in the narrow strip occupied by the sea. All doubts on this point were set at rest by the experimental soundings conducted by Sir J. Hawkshaw, and subsequently in greater detail by the French engineers, MM. Lavalley, Larousse, Potier, and de Lapparent ; 7,671 soundings were taken by these gentlemen, and 3,267 specimens of the bottom were brought up, nearly all of which could be identified with certainty as belonging to one or other of the formations named above. A geo-

[1] The thicknesses of the Chalk on the English coast are taken from the Geol. Survey Memoirs, vol. iv. ; those of the Bas-Boulonnais from the French Report of 1877, the thickness of the Lower Chalk being estimated by the position of the lowest beds of flint.

[2] There is some uncertainty as to the thickness of these divisions.



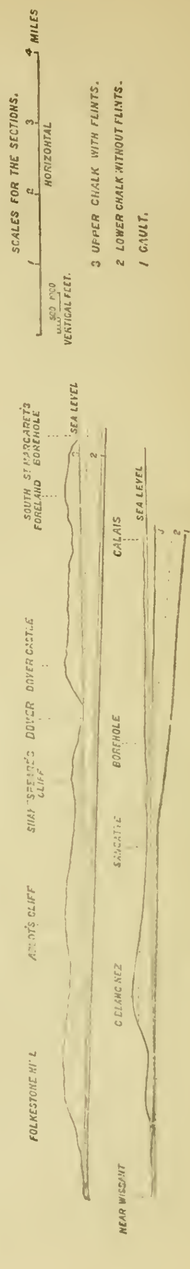


Fig. 1.—Geological Map of Channel; and Fig. 2.—Sections.

logical chart of the straits was thus made, showing the outcrops of the beds in the Channel from the Gault upwards. On this chart the submarine geology shown on the map (Fig. 1) accompanying this article is founded. The outcrop of the Gault is shown, and an approximate separation of the Lower Chalk from the Upper Chalk. It may be mentioned here that the lowest division of the chalk made by the French geologists, and known as the Craie de Rouen, does not exactly correspond with our Lower Chalk, which includes part of the overlying sub-division, the Craie Moyenne. The series of vertical sections (Fig. 3), which has been constructed to illustrate the remarkable persistence of the subdivisions of the Chalk, partly shows also the difference between the English and French classifications. The base of the Gault has been selected as an artificial datum line in plotting these sections.

The Lower Greensand on the other hand is probably represented only in its upper beds in the Boulonnais, while the Wealden beds are so changed and attenuated that the subdivisions made in England are unrecognisable in France. The Kimmeridge Clay reappears, but much reduced in thickness, as indeed is the case with all the lower secondary formations. For all these earlier beds rest upon an uneven rock-floor, carved out of a vast mass of contorted palæozoic rocks; and a ridge forming a prominent feature in this old surface existed in what is now the north part of the Bas-Boulonnais, and perhaps stoo above water through all the earlier part of the Secondary Period, until it was finally submerged beneath the water of the Gault sea. The filling up of the inequalities in the old surface probably contributed to the more even distribution of the Gault and Chalk. The only point at which the Palæozoic Rocks now appear at the surface in the district is in the north-east corner of the Bas-Boulonnais but they have been reached in boreholes in London Calais, and Guines as shown in the sections.

It was proposed by Prof. Prestwich to carry the tunnel through these Palæozoic rocks on the grounds that they are of great dimensions, and protected by overlying impermeable strata. But their great depth has prevented much attention being paid to the scheme; at Calais they are at 1160 feet below the surface, in London 1064, and near Battle in Sussex they have not been reached at 1900 feet. It has also been suggested that a tunnel starting in the Weald Clay on the English might be carried through into the Kimmeridge Clay on the French side without encountering the intervening Portland beds, it being supposed that these watery strata might thin out and leave the two clays in contact. But at the present time the inquiry has narrowed itself to the Chalk, the lower part of which is not only most suitable for tunnelling, but has the advantage of occupying the narrowest part of the Channel.

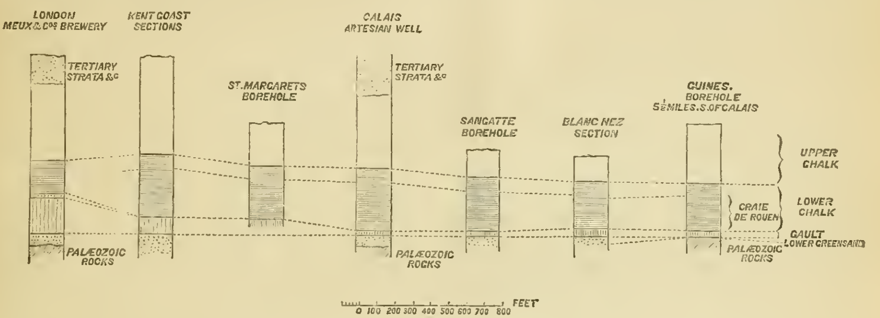


Fig. 3.—Sections showing the Persistence of the Lower Chalk.

The two schemes which are offered for tunnelling through the Chalk may be briefly stated as follows:—

1. The Channel Tunnel Company, with which Sir John Hawkshaw is connected, propose a tunnel starting from Biggin Street, Dover, with a gradient of 1 in 80, passing under the north spur of Dover Castle Hill, and thence continuing to a point on the shore known as the Fan Hole at a distance of 2 miles, 4 furlongs, 2·50 chains from Biggin Street, and at a depth of 115 feet below high water ordinary spring tides. From this point it will run across the straits to join the French tunnel, which commences near Sangatte, and as Sir J. Hawkshaw has always advocated a straight line of tunnel, we presume that such will be the case here.

2. The Submarine Continental Railway Company, with which Sir E. Watkin is associated, propose a tunnel connected with the South-Eastern Railway, about two furlongs west of Folkestone entrance of the Abbotscliff Tunnel by a tunnel descending at a gradient of 1 in 52 to the bottom of the No. 2 Shaft, near the west end of the Shakspeare Tunnel, at a depth of 126 feet below high water ordinary spring tides. From this point the tunnel will continue for about a mile towards the head of the pier in a direction slightly diverging from the shore, and finally curving round, will fall into the line of the French tunnel near Sangatte. In Sir John Hawkshaw's scheme the tunnel will start on the English coast in the lower part of the Upper Chalk, but will rapidly reach th Lower Chalk, and probably remain in it throughout. In that proposed by Sir Edward Watkin, the inclined plane leading to the tunnel, and the tunnel itself, will be driven from end to end in the same bed of grey chalk which constitutes the lower part of the subdivision of the Lower Chalk.

So far as our information goes at present it seems that the most serious obstacle will be water, and it is therefore on their relative liability to flooding that the proposed tunnels must be judged. In the Belgian Coal-field, where Coal-measures are worked under secondary strata full of water, it is found that those works are dry which "follow the vein," while those which cut across the strata are invaded by water. For the Coal-measures rise up to and end off in succession against the base of the secondary strata (which rest unconformably upon them), so that every bed, whether porous or not, is in contact with the water. It is clear then that a level, which cut across the strata, would run a far greater chance of intersecting a water-bearing rock than one which always followed the same bed. Now a precisely analogous position is held by the rocks which form the floor of the Channel relatively to the water which occupies it. The strata rising to the south-west crop out in succession in the sea-bottom, and, being for the most part bared by the scour of the tide, must be fully saturated with water. In an impermeable bed this would

make little or no difference to mining operations, but to encounter a porous bed such as the Lower Greensand under such circumstances would be to tap a reservoir as inexhaustible as the sea itself. Fortunately an excellent water-tight barrier between this quicksand and the Chalk above is provided in the Gault. The Upper Greensand, which lies next above the Gault, is generally thin, but occasionally expands rapidly from almost nothing to six or eight feet, and, though as rapidly dwindling down again, it might under such circumstances conduct a large amount of water. The French engineers have tested it at intervals by borings in the drift-ways, and have observed that water rises from it in most cases. But it is generally too insignificant to prove dangerous.

That it would be advisable to choose the most favourable bed, and to follow it for the whole distance, if this were possible, is not to be denied. But a study of the map shows that to do this it would be necessary either to make at least two considerable curves in the tunnel, or else to make it rise and fall with the beds, which would probably be prejudicial to drainage and ventilation. For the form of the outcrop of the Gault shows that close to both shores the strata are bent upwards in the form known to geologists as anticlinals. The outcrops incline to the north-east in such a way that the Gault occupies a position in the line of prolongation of the Lower Chalk, indicating clearly that it is arched upwards at these points, and therefore intersects the sea-bottom further to the north-east than it would if it formed a plane surface. The anticlinal which passes near Sangatte is partly shown in one of the longitudinal sections accompanying the map, but would be more manifest in a section running in the direction of the proposed tunnel. Again, about midway between Dover and Folkestone an isolated patch of Gault appears through the Lower Chalk. This patch is believed to be bounded on the south-west by a fault, not necessarily of large amount, and probably dying out to a mere gentle roll in the strata seaward. To make the lie of the beds more intelligible, the French engineers calculated the position of three horizontal lines following the top of the Gault at a depth of 50, 100, and 150 mètres respectively below low-water mark, and one of these has been placed upon the map accompanying this article. The inequalities of the surface of the Gault are shown by this line in the same way that the inequalities of the ground are shown by a contour line.

The thickness of the Lower Chalk is such that in spite of these undulations in the beds a tunnel originally planned to run near the middle of the subdivision, might continue a straight course with an unchanged gradient, and still remain with its limits. But if running near the top a synclinal or downward bend would bring the Upper Chalk into the line of the tunnel, while if running near the bottom, an anticlinal or upward bend would bring in the Gault. It is obvious then that a tunnel traversing the lower portion of the Chalk, on encountering an anticlinal, would be compelled to bend towards the north-east in order to preserve a constant gradient, and at the same time avoid touching the Gault. It is believed that the route advocated by Sir E. Watkin is so planned as to round the two anticlinals described above, as occurring on either side of the Channel. It remains to be seen whether the form of the beds will admit of its being carried in a straight line, and at the same time in the bottom beds of the Chalk, for the remainder of the distance. In the route proposed by Sir John Hawkshaw, the effect of an anticlinal would be to bring up the lower beds of the Chalk into the line of tunnel, and would therefore not be unfavourable; a synclinal might probably bring down the Upper Chalk with flints, which, as will be shown subsequently, is not desirable.

A similar source of uncertainty exists in the possible occurrence of faults, that is, lines of fracture in the strata, on one side or other of which they have been vertically shifted. The Gault in mid-channel being presumably about 50 or 60 feet thick, a fault of this amount might bring the base of the Chalk and the top of the Lower Greensand face to face. The submarine mapping, however, if it can be trusted, shows that it is very improbable that there is a fault of this amount in the channel. A fault would displace all the beds of the Chalk in succession equally or nearly so, but its effect would be less perceptible higher in the system where chalk would be thrown against chalk, than at the base where chalk might be thrown against the Gault or Greensand. It remains to be considered which of the subdivisions of the Chalk is the most suitable for operations, and whether sufficient difference exists between the various beds to make the experience of the Belgian miners directly applicable to the Channel Tunnel.

The lower part of the Grey Chalk, the lowest subdivision of the Chalk as shown in the table, is universally stated to be very impermeable. Prof. Prestwich, in the "Water-bearing Strata of London," p. 63, states: "The lower beds of the Chalk are generally so argillaceous that the rock often puts on the character of an argillaceous clay, which on exposure to air and water softens to a tenacious mud. When first exposed its colour is bluish grey, but it becomes white or nearly so as it dries. . . . They everywhere form a generally impermeable mass of strata, between the Upper and the Middle Chalk above, and the Upper Greensand below." The Grey Chalk or Craie de Rouen, about 60 to 70 feet from its base, throws out springs. The powerful spring of Lydden Spout, for example, is thrown out at about this horizon, where a small fault, probably the continuation of that inferred by the French in the Channel, slightly disturbs the beds. Springs are observable also on the French coast between Sangatte and Wissant at this horizon. The compact nodular Chalk is very impermeable; Prof. Ed. Hébert (*Bull.* Soc. Geol. de France, Ser. 3, t. iv. p. 60) states that the highest part of the Chalk without flints is preferable as regards impermeability to the Craie de Rouen itself; it has never yielded water in any of the Artesian wells near Paris, and is always clayey when met with at great depths. The various sub-divisions which constitute the Lower Chalk form the undercliff from about two miles east of Folkestone, as far as the South Eastern Railway Terminus. Dipping gently down to the north-east, they were reached at 249 feet below sea-level at St. Margaret's Bay in Sir John Hawkshaw's borehole.[1]

The divisions of the Upper Chalk, namely the Chalk with flints, and the Chalk with few flints, differ chiefly in the mode of occurrence of the flints; in the former they occur in layers, in the latter they are scattered and far between. This difference is important, for the layers of flint often give rise to channels by which water circulates in the chalk. The chalk with a few flints occupies the beach from Dover Castle eastwards, until it is succeeded in due course by the Chalk with layers of flints. The former throws out a few springs, the latter a large number, and it is generally agreed that the Upper Chalk, and particularly the chalk with layers of flints, is the most heavily watered part of the formation.

The circulation of water in chalk takes place principally by means of fissures, the unfissured rock being of such close texture as to be practically impermeable. Prof. Prestwich, for example, has estimated the relative permeability of chalk and coarse sand to be as 1 to 6400. But when the fissures are numerous, and the rock contains layers of flints, the water is enabled to circulate with great freedom. The Upper Chalk is more liable to fissures than the argillaceous lower division, and for this reason excels it as a water-bearing formation.

[1] See sections (Fig. 2) accompanying the map. These have been copied with slight modifications from a paper by Mr. Topley in the *Quarterly Journal of Science* for April, 1872.

Now the principal difference between the two proposed routes consists in the fact that Sir E. Watkins' tunnel starts in the impermeable portion of the chalk with a view to following it all across, while Sir J. Hawkshaw's tunnel starts in the lower part of the Upper Chalk, and descends subsequently into the Lower Chalk, probably into that portion of it which, as stated by Prof. Hébert, is less permeable than the Craie de Rouen itself. The possible difficulties that may arise from following the base of the chalk too closely have already been pointed out. It remains to be seen how far the fact of starting in the Upper Chalk is prejudicial.

In spite of the vast quantities of water that have been obtained from the Chalk,[1] there are many instances of wells and deep bore-holes having failed to obtain a supply. A well at Dover Castle, 363 feet deep, or 1½ feet below low-water mark, and with a tunnel 160 feet long at the bottom, can be pumped dry in three hours by a 30 horse-power engine (Statement by the Committee of the Channel Tunnel Company). Deep bore-holes, such as those at Harwich, Hampstead, Calais, and Grenelle, though traversing the whole Chalk system, have been unsuccessful, and many other instances might be quoted to show how uncertain is the amount obtainable by this means. The plan adopted at Ramsgate, and afterwards at Brighton in consequence of the supply from wells being inadequate, throws much light on the circulation of water in chalk. Mr. Easton (Brit. Assoc. Rep. 1872) states that a well was sunk, and the direction of the fissures having been ascertained, a tunnel was driven at right angles to them, so as to intercept the greatest number in the shortest distance. Such a tunnel driven under Goldstone Bottom traversed 160 feet of solid chalk without finding water. It then encountered an enormous fissure yielding 1000 gallons per minute. This was followed at about the same interval by another of about equal capacity. At the Lewes Road the fissures were about 30 feet apart and yielded about 100 to 150 gallons per minute. At Ramsgate the supply was obtained by driving parallel to the shore at about low water-mark. The fissures were observed by Mr. Easton to run at about right angles to the coast line, so that it is clear that a tunnel might have been driven in this direction for a long distance without cutting a fissure. That a tunnel can be driven even in the most favourable situation for tapping water has been proved by Sir J. Hawkshaw, who, in the discussion which followed Prof. Prestwich's paper (*Proc.* Inst. C.E. xxvii.), stated that "he was now completing at Brighton a tunnel of 5¼ miles in length, wholly through the Upper Chalk and below the level and within a short distance of the sea. There was a large amount of water from land-springs. The quantity of water pumped varied from 8,600 to 10,000 gallons per minute. This was a large quantity, but it did not prevent the tunnel from proceeding." The same length of tunnelling taken seawards at a greater depth might have carried the works clear of these difficulties, for there is reason to believe the fissures are most numerous and widest above or near the sea-level.

These fissures, originally mere cracks due to unequal contraction or expansion in the mass of the chalk, owe their enlargement to the passage of water through them, acting partly mechanically by erosion, partly chemically by dissolving the carbonate of lime. Although they are met with at considerable depths, as for instance in the borehole at St. Margaret's Bay, where a cavity of 3 feet depth, and filled with salt water, was found at 209 feet, yet they are most numerous where the circulation is most active, namely, about the water-level. It is at this level, as well as above the outcrop of an impermeable bed, that the largest inland springs occur, and it is at the sea-level that the largest quantity of water escapes from the cliffs on the coast. Beneath the waters of the Channel there may be but little movement in the rock-water, and what fissures or faults may exist, as well as the channels following the layers of flints are probably more or less choked from long disuse. While therefore it is not likely that the approaches to a tunnel can be made under the coast in the Upper Chalk without meeting with much water, it does not necessarily follow that the quantity will be so great as to be utterly unmanageable. That it is expected to be considerable may be inferred from a statement by Sir John Hawkshaw in the discussion before referred to, that the engines used in the Brighton tunnel "were, in the aggregate, of 150 horse-power, but provision had been made in estimating the possible cost of the Channel tunnel, for engines of about 2000 horse-power."

Finally, it may be stated that the works, so far as they have gone, have confirmed the expectations formed as to the character of the rocks. The shaft at the west end of Abbot's Cliff Tunnel has been taken to a depth of 160 feet, and a drift-way carried in the Lower Chalk for 1100 yards in the line of the tunnel proposed by Sir E. Watkin, without meeting water. On the French side two shafts have been sunk near Sangatte to a depth of 280 feet, entering the Craie de Rouen at the sea-level, and a tunnel has been driven in a north-easterly direction at about 170 feet below the sea-level, with trial holes at intervals to the Gault, which is about 7 feet below. A little water issues from these, but the total amount that has to be pumped does not exceed 80 gallons a minute. Up to the present time no further trials have been made in the Upper Chalk at the spot selected for the works by Sir J. Hawkshaw.

A. STRAHAN

[1] In the discussion on a paper by Mr. Lucas (*Proc.* Inst. C.E. xlvii.) Mr. Homersham stated that 11,000,000 to 12,000,000 gallons daily had been taken from the chalk in an area of 150 square miles about London for some years.

SIR CHARLES WYVILLE THOMSON

THE news of the death of Sir Wyville Thomson, on the 10th instant, from the effects of paralysis, will be received with general regret. Sir Wyville was only in the 53rd year of his age. On the return of the *Challenger*, we gave so full an account of Sir Wyville's life and work (vol. xiv. p. 85) that we need not go over the same ground again.

Charles Wyville Thomson was a descendant of an old Scottish family which had long resided at Bonsyde, Linlithgow. His father was a surgeon in the service of the East India Company. Born at the family residence on March 5, 1830, Wyville Thomson became, at the age of twenty-one, a lecturer on Botany in King's College, Aberdeen. In 1853 he became Professor of Natural History in Queen's College, Cork; but he had only been there a year when he succeeded to the Chair of Mineralogy and Geology in Queen's College, Belfast. In the expeditions of the *Lightning* and *Porcupine* in 1868 and 1869 he took part, and the discoveries then made in regard to the fauna of the Atlantic Ocean he subsequently gave to the world in a work entitled "The Depths of the Sea." On the resignation of Prof. Allman, Prof. Thomson was elected Regius Professor of Natural History in the University of Edinburgh, where his abilities as a lecturer raised the class of zoology to a position of great importance, the numbers attending it being probably unequalled. Of the famous expedition in the *Challenger*, Prof. Thomson was appointed the scientific chief. Leaving England in 1872, the exploring party was absent for three and a half years, during which time 68,890 miles were traversed, and systematic observations made at 362 stations in the open sea, notes being also made on land and in shallow water, as opportunity offered. The natural history and other collections obtained were very extensive. These large collections were from time to time sent home to Edinburgh, where the head office of the expedition was subsequently established; and it was only appropriate

that as he had gathered them from the previously "unfathomed depths of ocean" in all climes, the direction of the work of describing and reporting upon the specimens should be entrusted by the Treasury to Prof. Thomson. For the last two years, however, Prof. Thomson has not been able to do much in connection with this important work, which has, in consequence, largely devolved upon his able first assistant, Mr. John Murray, who, in the beginning of the present year, was on account of the state of health of his chief, appointed director.

Immediately on his return to this country from his extended voyaging, Prof. Thomson's services to the cause of science were acknowledged in various quarters. On June 27 he received the honour of knighthood; the Royal Society of London awarded him one of its gold medals; and in July of the same year he, along with the other members of the scientific staff of the *Challenger*, were entertained at a banquet in Edinburgh, at which the toast of the evening was proposed in eulogistic terms by Prof. Huxley. Subsequently, when, along with Emeritus Professor Balfour, he went as the representative of the Edinburgh Senatus to Upsala on the occasion of the tercentenary of that ancient University, the King of Sweden created him a Knight of the Order of the Polar Star. Sir Wyville was also an LL.D. of Aberdeen, a D.C.L. of Dublin, a Doctor of Philosophy of the University of Jena, a D.Sc., a Fellow of the Royal Societies of London and Edinburgh, of the Linnean Society, and of various foreign and colonial institutes. In 1877 Sir Wyville was appointed to deliver the Rede Lecture at Cambridge; and in 1878 he presided over the Geographical Section of the British Association at its meeting in Dublin. In addition to numerous memorials on zoological subjects, and contributions to the proceedings of the scientific societies with which he was connected, Sir Wyville also wrote a preliminary account of the general results of the *Challenger* Expedition, which was published in two volumes under the titles of the "Voyage of the *Challenger*—The Atlantic."

After his return in 1876 from the voyage of the *Challenger* Expedition, it was remarked that his long spell of travel had not brought increased physical vigour; but it was not until 1879 that his condition gave his friends serious cause for uneasiness. In June of that year he was prostrated by an attack of paralysis, and unable to conduct his class of Natural History in the University of Edinburgh, and the important undertaking in which he was engaged, of directing the working out of the *Challenger* researches, with the view of furnishing to the world a complete record of the results, had to be laid aside, only to be intermittently touched again before the time came when he had to resign it entirely into other hands. In October last he resigned his Chair in the University, and we believe that arrangements had just been completed by the Senatus in respect to his retiring allowance. Some four months ago he had a second paralytic attack, and since then his health has been feeble. He died on Friday morning at three o'clock.

The departments of zoology to which he devoted most attention were those which included the corals, crinoids, and sponges, and upon these his opinion was regarded as of great weight. In the University he was held in esteem by his colleagues of the Senatus, and among the students he was exceedingly popular. In private life he was regarded by his friends as possessed of a kindly and hospitable disposition.

Sir Wyville Thomson married a sister of the late Mr. Adam Dawson of Bonnytoun, Linlithgowshire, for some years Provost of Linlithgow, whose father also occupied the same honourable position for the greater part of his life. He is survived by Lady Thomson and one son, an M.A. of the University of Edinburgh, who is at present engaged in the study of law.

THOMAS ROMNEY ROBINSON, D.D.

THOMAS ROMNEY ROBINSON, D.D., F.R.S., whose death we recorded in our last issue, was born in Dublin on April 23, 1793. His abilities and genius seem to have been manifested at a very early age, and his first appearance as an author dates so far back as 1806. On that occasion his venture was entitled "Juvenile Poems by Thomas Romney Robinson, to which is prefixed a short account of the Author by a Member of the Belfast Literary Society:" Belfast, 1806. The book contains a number of poems written by the author at various ages below thirteen. Dr. Robinson's last publication is in the *Philosophical Transactions* for 1880, and it must be regarded as a curious circumstance in literary history that an interval of three-quarters of a century should have elapsed between Dr. Robinson's first appearance as an amateur and his last.

In the year 1814 Dr. Robinson was elected a Fellow of Trinity College, Dublin, and he was for several years engaged in lecturing in the University as Deputy Professor of Natural Philosophy. In connection with his labours as a teacher he published in 1820 a volume entitled "A System of Medicine for the use of Students in the Dublin University."

After a residence for nine years at Dublin University, Dr. Robinson accepted the living of Enniskillen, which was in the gift of Trinity College. Robinson's career in the University was thus finished the year before Humphrey Lloyd, the late Provost, was elected to a fellowship.

Dr. Robinson did not long remain Rector of Enniskillen. In the year 1824 he exchanged the living of Enniskillen for that of Carrickmacross; and of his ecclesiastical career there is little further to note, except that about half a century later (in the year 1872) he was nominated a Prebendary of St. Patrick's Cathedral, Dublin, and that several of his sermons have been published.

Dr. Robinson is principally known to fame by his connection with the Armagh Observatory. The observatory at Armagh was founded in 1793 by Primate Robinson. The endowment of the observatory, as well as that of a public library, arose out of Primate Robinson's scheme of forming at Armagh a university which might serve for the education of the North of Ireland. It is needless to say that the greater part of the Primate's beneficent scheme was never realised. At his death the meridian instruments he had ordered for the observatory seem to have been countermanded by his heirs. The two succeeding primates had but little interest in science, and it was not until they were succeeded by Lord John George Beresford, the late Primate, that any further steps were taken. Primate Beresford presented to the observatory a transit instrument, a mural circle, and an equatorial reflector of fifteen inches' aperture. The first of these was erected in 1827, and the last in 1835. It was in the year 1824 that Dr. Robinson was appointed director of the Armagh Observatory. He threw himself into the work of practical astronomy with the greatest zeal and success, and the celebrated "Armagh Catalogue" is a noble monument of his assiduity and skill. This catalogue, though not published until 1859, contains many observations of stars between the years 1830-40, of which we possess few contemporary observations. On this account the Armagh Catalogue has a distinct value, and it has been much used by Argelander in his investigations of the proper motion of 250 stars in vol. vii. of the Bonn Observations.

The mural circle at Armagh was subsequently furnished with a new telescope having an objective of 7 inches' aperture, and with this 1000 of Lalande's stars, nearly all between 6·0 and 7·5 magnitude were re-observed in 1868-76, and the results have been published in the *Transactions* of the Royal Dublin Society, new series, vol. i.

Dr. Robinson's determination of the constant of nutation also deserves notice, though for reasons which need

not now be discussed it has never come into practical use among astronomers.

The celebrated cup anemometers, now so extensively used, are an indication of the practical skill and ingenuity by which Dr. Robinson was distinguished. The very latest scientific labour of his long life was a redetermination of the constants of the cup anemometer. This was accomplished by experiments on a very large scale, in the dome of Mr. Grubb's workshops, at Dublin. The results of these labours have been published in the *Phil. Trans.*, 1878-1880.

Considering that Dr. Robinson was an author before the battle of Trafalgar, that he was elected a Fellow before the battle of Waterloo, and that he was made director of the Armagh Observatory within a year or two of the death of Sir W. Herschel, it is not surprising to find that Dr. Robinson's scientific friends and associates belonged mainly to the past generation. In that past generation, Dr. Robinson occupied a distinguished and remarkable position. He was intimately associated with the late Earl of Rosse in all those memorable experiments which culminated in the great reflector at Parsonstown. He was the friend of Sir James South, of Sir William Fairbairn, and of many other celebrities. His wide sympathy, his gentle and invariable kindness, his wondrous stores of knowledge, his charming powers of conversation, his brilliant eloquence, were qualities universally recognised, and caused him to be welcomed and beloved in many circles besides those purely scientific.

NOTES

We learn that Dr. Huggins obtained a photograph of the spectrum of the great nebula in Orion on the 7th inst., and that in addition to known lines, it shows a strong line in the ultra-violet.

The death is announced, at the early age of forty-six years, of Prof. A. Freire Marreco, who filled the Chair of Chemistry in the Newcastle College of Science. Prof. Marreco had a considerable reputation as a working chemist, and did much to promote the cause of science in the north of England.

The death is announced of Herr J. J. Sievers, the well-known astronomer, who died at Altona on February 22 last, aged seventy-seven.

At the dinner given by the Lord Mayor on Saturday to a large number of gentlemen who have shown an interest in the Smoke Abatement Exhibition, Mr. Shaw Lefevre pointed out that we had advanced nothing in the cure of London fogs since the days of Evelyn, who gave great attention to the subject. Mr. Ernest Hart, the Chairman of the Committee, spoke of the loss by dirt and the loss by darkness, amounting to many millions, occasioned by smoke and fog; and, referring to the late exhibition, said the scientific results were most satisfying and encouraging. Many excellent inventions proved the perfect practicability of abating smoke from domestic grates, and especially from kitcheners (which were now the greatest offenders), and there was not an industry in the country which would not be benefited by an application of some one or other of the exhibits. Mr. Hart adduced some striking statistics to show the serious loss of life by the recent London fogs, and stated that during these fogs he had telegraphed to various places just outside London, and found that the weather was clear and beautiful. Surely some earnest effort will now be made to abate the serious nuisance.

In a note on the appointment to the Edinburgh Natural History Chair, the *Spectator* of March 11 says: "There is a great, though not obtrusive, dissatisfaction in Scotch educational circles, and even beyond them, at the unprecedented delay of the Home Office in filling up the Chair of Natural History in the University of Edinburgh, which Sir Wyville Thomson long ago resigned. The post is the academic blue riband of natural science in Great Britain. The annual emoluments, between fees and endowment, come to close upon 2000*l*. The work of the Chair is not arduous, and the occupant has the advantage of living in the most charming of provincial cities, and of being lionised by its society. Some of the most eminent biologists in the United Kingdom, including the Professors of Natural History in the three other Scotch Universities of Glasgow, Aberdeen, and St. Andrew's, are candidates for the Chair. But Lord Rosebery, with whom, as Under-Home Secretary, the appointment virtually lies, is understood all over the country—we hope falsely—to be desirous to appoint Prof. Ray Lankester, of University College, whose cause is actively championed by Prof. Huxley. Able as Prof. Ray Lankester is, we should greatly regret, in the interests of Scotland, to see the appointment of so very relentless a champion of vivisection, nay, even of a large extension of vivisection, to a Chair of influence in Edinburgh." This is a fine instance of good taste and sound judgment. If Prof. Lankester's high qualifications are recognised, Lord Rosebery is not likely to be influenced by a bye question, urged especially in such a way from such a quarter.

The Society of Chemical Industry has proved so far successful that they have been able to begin the publication of a *Journal* intended as a "Monthly Record for all interested in Chemical Manufactures." The first number was published in January, and contains various reports connected with the Society and its branches, a paper on Artificial Indigo, by Professors Roscoe and Baeyer, and a number of interesting notes. Prof. Abel's address at the opening of the London section is of great interest as showing in a great variety of instances the intimate dependence of manufactures on success in improvement of chemical processes, and advance in chemical research. "It is, indeed, I submit," Prof. Abel said, "the special duty of this section of the Society to demonstrate, by its activity, how intimately interested in the advancement of applied chemistry, physics, and mechanics, are a large number of trades which are practised in the metropolitan area, and how closely allied to each other in regard to their interests in the development of chemical and engineering science are many trades which, to the general public or the superficial observer, would appear to have little interest in common. Certainly, in no part of Her Majesty's kingdom, I may say of the universe, can be found congregated together so great a variety of important manufacturing trades—all of them deriving direct advantage from the advance and the application of science—as exist within our metropolitan area and its immediate environs. Thus, among those whose trades, pursued in and around the metropolis, may be considered to bring them within the possible scope of activity of a society founded for the advancement of chemical industries, we have the manufacturers of definite chemical products, of drugs, and of pharmaceutical preparations, of white lead and other mineral colours, of varnishes and lacquers, of all the various products of coal-tar distillation, from creosote and pitch to dyes of the greatest beauty and purity; of manures, of cements, of candles, soaps, and lubricants; the refiners of sugar, of oils, and of metals; brewers, distillers, tanners, makers of glue and size, of pottery, stoneware, and glass, of gunpowder and pyrotechnic compositions, of waterproof goods and insulating materials. Extensive as this list is, it might probably be added to considerably." It is evident there is ample scope for the work of such a society as this, and on its present lines it is likely to do much good.

Prof. Haeckel, of Jena, has now concluded the zoological work he was conducting on the south coast of Ceylon during two months, and has sent over fifty cases with natural history collections to Jena. His researches on the Ceylon coral reefs were

highly successful, and led to the discovery of many new species. During February Prof. Haeckel visited the mountains, and by now is probably on his way back to Jena.

THE existence in Northern Russia, and especially in the neighbourhood of St. Petersburg, of a bottom-moraine, like that which covers Sweden, Finland, North Germany, and the north of Britain, was long doubted. The researches of Prof. Inostrantzeff along the diggings of the new Ladoga canal (*Memoirs* of the St. Petersburg Society of Naturalists, vol. xii.) do not leave, however, any doubt on this subject. The Devonian rocks which appear between the rivers Syass and Svir (the geological map of Prof. Helmersen having to be modified in this respect) are covered with a thick sheet of typical bottom-moraine. It consists of a grey or reddish, unstratified and earthy mass of sand and clay containing both small rubbish and great boulders, sometimes 10 feet in diameter. The boulders consist of granite, gneiss, sandstone, and slates, these last being most numerous, and exhibiting beautiful polished and scratched surfaces. At some places the thickness of the bottom-moraine reaches 14 feet, and it is interesting to observe how the advance of the ice-sheet has folded and plaited the ends of the Devonian strata, the moraine matter being sometimes thrust between them. The washed and stratified sands which cover the bottom-moraine contain numerous remains of prehistoric man. These researches of Prof. Inostrantseff are completely confirmed by those of M. Dokoutchaieff, who has explored the ridges of sands and gravels (*osar*) on the eastern coast of the Gulf of Finland. While several of them are simple dunes, kames, or eskers, others are completely composed of typical glacial gravel (*krossstensgrus* of Swedish geologists), or of the same gravel covered with a mantle of more recent stratified sands. Both are of morainic origin.

AT a recent meeting of the Asiatic Society of Japan, says the *Japan Mail*, Prof. John Milne, of Tokio, read a paper on the *Koro-pok-guru*, or Pit-dwellers of the Island of Yeso. This name is that used by the Ainos, and means, literally, "people having depressions." According to the Aino accounts this race lived in huts built over holes, and knew the art of pottery. Mr. Milne found and examined pits on a small island near Nemuro, the north-east port of Yeso, and among the Kurile Islands. Near them were found flint arrow-heads and fragments of earthenware. The Japanese say that the pits, which are rectangular in shape, were inhabited by a race of *Kohito*, or dwarfs, which was exterminated by the Ainos. In the extreme north of the Kuriles Mr. Milne met with the aborigines of these islands dwelling in huts built over pits, which were, in general appearance, identical with the pits found farther south. In Saghalin and Kamschatka also, certain tribes dwell in pits. The general conclusion to which the writer comes is that the modern representatives of the pit-dwellers are the Kurilsky, and some of the inhabitants of Saghalin and Kamschatka, who, like the Esquimo of the Atlantic sea-board, had in former times extended much farther south. Several facts were also adduced to show that the shell-heaps of Japan were of Aino formation. Mr. Milne suggested that the hairy Ainos were connected with the hairy Papuans, who at one time extended from their present home in the south in a continuous line through the Philippines to Japan. Malay races invaded this line in the Philippines, so that all that remain of the aboriginal stock are the hairy Aeta. In Formosa, Oshima, Satsuma, and other parts of Japan, links of the hairy, large-eyed, round-faced Aino type are still to be found. The modern Japanese invaded the line from the direction of Corea, and as they exterminated or drove the Aino towards the north, the Aino in his turn pressed upon the *Koro-pok-guru*, who retreated to more northern regions, leaving behind him, as indications of his former presence, the pit-like depressions found in so many parts of Yeso. In the discussion which followed, Mr. Satow remarked that the old Japanese chronicles indicated the presence in Eastern Japan of other tribes of barbarians besides the Ainos. He agreed with Mr. Milne's theory of an early Mongoloid immigration, which probably came by way of the Korean peninsula, and was established in the western provinces before the advent of the ancestors of the ruling family, who entered Japan from the south of Kiushiu, and were probably of Malay origin.

A SOCIETY for the study of the French language which has been established amongst the Japanese in Tokio, is about to publish a complete history of the country in French.

THE annual prize of the Russian Academy of Sciences, bearing the name of Academician Brandt, has been awarded to Prof. K. Meller, for his researches on the Russian Coal-basins. The prize of Prof. Bouniakovsky remained unawarded, few larger works of value having been published last year in Russia in the Natural Sciences Department.

IN a paper on "Ozonised Air as an Anæsthetic," by Dr. C. Binz, of Bonn, in the Berlin *Medical Journal* (1882, 1 and 2), the author brings forward a number of interesting experiments on the effect of breathing small amounts of ozone. The gas was in all instances employed mixed with air and produced by the silent discharge. The effect on small animals was very marked, first becoming somewhat unquiet, and then the breathing less frequent, a state of torpor finally ensuing. No appreciable action on the heart appeared to have taken place at this stage. The bodily heat however becomes much lowered, and irritation and inflammation of the air-passages, causing vomiting, ensuing. The experiments with human beings show considerable differences in effect on individuals. Generally sleep ensued in from seven to twenty minutes, being preceded by a feeling of greater ease in breathing. The sleep was generally also very deep, being followed by a tired sensation for some minutes. The continuation of the experiments demonstrated, however, that although ozone is not by any means so irritating and destructive in its effect on delicate membranes as hitherto stated, it would be quite impossible to employ it as an anæsthetic to replace nitrous oxide.

A RICH discovery of Lacustrine relics has been made at Steckborn, on Lake Constance. They consist of flint and bone implements, pottery, bones of animals now extinct, and a quantity of wheat and oats. The relics have been placed in the Frauenfeld Museum.

DURING last year the Council of the Meteorological Society, having regard to the rapid progress of late years in statistical meteorology, and the uncertainty that still prevails regarding important questions relating to the physics of the atmosphere, considered it desirable that the Society should supplement the ordinary observations by a series of well-conducted experiments destined to throw light on such questions as the vertical decrement of temperature, the rate of ascension of vapour, the height of cloud-strata, the variation in the velocity of the wind at different elevations, &c. Steps have been taken during the past week to make observations on the first of the questions by the placing of thermometers at the summit and base of Boston Church Tower, which is 270 feet high. This tower is admirably situated for making such experiments, as it is isolated and free from any obstructions, and the ground is quite flat for miles round. By permission of the vicar, Canon Blenkin, the instruments have been placed as follows:—At the summit one of Dr. Siemens' electrical thermometers (kindly placed at the Society's disposal by Messrs. Siemens Bros. and Co.) and an ordinary thermometer are mounted in a small screen fixed to one of the pinnacles of the tower; on the roof of the belfry, which is 170 feet above the ground, a Stevenson screen has been mounted containing maximum, minimum, dry and wet bulb thermometers.

In the churchyard, another Stevenson screen has been fixed containing a similar set of thermometers, for comparison with those above. All the thermometers will be read every morning at nine o'clock. The electrical thermometer consists of a coil of wire wound round a cylindrical piece of wood inclosed in a small brass tube, a third wire is joined to one of the wires, and the three insulated by gutta-percha, form a light cable which is brought down to the base of the tower and connected to a galvanometer, the terminals of which are in connection with the two poles of a six-cell Leclanché galvanic battery. The instrument is read by depressing a key, which causes the needle of the galvanometer to deflect; a pointer or vernier (moving a contact roller upon a wire in a circular groove) is then pushed to the right or to the left upon a divided scale until the needle remains stationary on the zero point, when the electrical resistance of the wire is measured upon the scale. The number indicated by the vernier is then read off, and by referring to a table of equivalents the actual temperature in degrees of Fahrenheit is readily ascertained. Simultaneous readings of the electrical thermometer at the summit of the tower and of the dry bulb thermometer in the churchyard will be made frequently during the day by the verger of the church.

A RUSSIAN naval officer has invented a very ingenious apparatus for ascertaining the depth of the sea without the use of a costly and heavy line. Indeed, no line at all is used. The instrument consists of a piece of lead, a small wheel with a contrivance for registering the number of revolutions, and a float. While the apparatus sinks, the wheel revolves, and the registered revolutions indicate the depth. When the bottom is reached, the lead becomes detached, the float begins to act, and the machine shoots up to the surface, where it can easily be fished up by a net and the register read off.

PROF. WEGMÜLLER, the eminent Munich sculptor, is hard at work at the monument of Baron Justus von Liebig, the eminent chemist, which will be erected in the Public Gardens at the Maximilian's platz of Munich. It is of Carrara marble and over life size.

THE enterprising people of Paisley, near Glasgow, are to have a popular observatory attached to their Free Library and Museum, mainly through the liberality of Mr. Thomas Coats, who, with the assistance of Prof. Grant, of Glasgow, has not only purchased a suitable equatorial with all necessary adjustments, and a cupola, but is erecting a tower for the reception of the instrument. Similar institutions in the provinces might take a hint from Paisley.

M. DE FREYCINET, the French Minister of Public Affairs, has declared himself a candidate for the next election to the Academy of Sciences, to fill the seat vacated by M. de Bussy's recent death. His claim is grounded on the publication of books relating to engineering and the integral calculus. M. Paul Bert, the late Minister of Public Instruction is also offering himself for election, but in the section of Surgery and Medicine.

BAEYER, in continuing his investigations on indigo (*Berichte*, xv. 50), arrives at probable structural formulæ for the molecules of this compound and some of its derivatives. Some light has been thrown on chemical changes which occur in the manufacture of *yellow prussiate of potash* by the observation of Remsen (*Amer. Chem. Jnl.*, iii. 134), that a cyanide of iron is formed when iron, which has been reduced by hydrogen and organic matter, is heated with metallic sodium in an atmosphere of hydrogen.

THE *Panama Star and Herald* of Monday announces that an earthquake has occurred in Costa Rica, by which the towns of Alajuela, San Ramon, Grecia, and Heredia have been destroyed. It was at first stated that several thousand persons had perished, but according to later information, the loss has been grossly exaggerated.

FROM April 11 to 16 a Pedagogical Congress will meet at the Sorbonne, under the presidency of the French Minister of Public Instruction, who will be, as in former years, M. Ferry. The male public teachers will, as in 1881, send their delegates; but a great innovation will take place—the female teachers will for the first time enjoy the same privilege. The *Journal Officiel* has already published the programme of questions which will be discussed in this characteristic session.

MOVEMENTS of the ground appear to be now going on in the Jura. M. Girardot has lately pointed out that villages that were invisible to each other at the beginning of the century, and even thirty to forty years ago, are now visible. First the roofs appeared, then (in part) the walls. Such is the case with the villages of Doucier and Marigny, near Lake Chalain. Important changes have been observed even within ten years.

A LARGE meteorite fell at Mirotch Planina (Eastern Servia), on February 21 last.

WE have on our table the following books:—A Monograph of the Insectivora, Systematic and Anatomical, by G. E. Dobson (Van Voorst); Leçons sur L'Electrici é et le Magnétisme, by E. Maxart and J. Joubert (G. Masson); The Use of Gas as a Workshop Tool, by Thos. Fletcher, Warrington; Contributions to Meteorology, by Elias Loomis; Punjab Customary Law, 3 vols., by C. L. Tupper (Quaritch); Geology of the Counties of England, by W. J. Harrison (Kelly and Co.); The Sun, by C. A. Young (Kegan Paul and Co.); Hesperothen, 2 vols., by W. H. Russell (Low and Co.); A Plea for the Rain-band, by J. Rand Capron; Pioneering in the Far East, by Ludwig Verner Helms (W. H. Allen); Ferments et Maladies, by E. Duclaux (G. Masson); Commercial Organic Analysis, vol. ii., by A. H. Allen (Churchill); Manitoba, by Rev. G. Bryce (Low and Co.); Electric Lighting, 3rd edition, by Killingworth Hedges (Spon); Blackie's Imperial Dictionary, vol. ii.; Preparation for Science Teaching, by John Spanton (Griffith and Farran); Ueber die Dauer des Lebens, by Dr. A. Weismann (Fischer, Jena); Die Magneto und Dynamo-elektrischen Maschinen, by Dr. H. Schellen (Dumont-Schanberg); Acoustics, Light, and Heat, by N. E. William Lees (Collins); Experimental Chemistry, Part I., by Prof. J. Emerson Reynolds (Longman); Geology and Resources of the Black Hills of Dakota (Government Office, Washington, D.C.); Atlas to the same; Magnetism and Electricity, by R. Wormell (Murby).

THE additions to the Zoological Society's Gardens during the past week include a Water Vole (*Arvicola amphibius*), British, presented by Mr. W. K. Stanley; two Common Buzzards (*Buteo vulgaris*) from Scotland, presented by Mr. W. M. Baillie; a —— Harrier (*Circus*, sp. inc.) from South Africa, presented by Mr. Cole; a West African Python (*Python sebæ*) from West Africa, deposited; a Muscat Gazelle (*Gazella muscatensis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

VARIABLE STARS.—Prof. Julius Schmidt has published his variable-star results for 1881, which evince the same assiduity of observation as in so many years past. Seven minima of Algol were determined; the last occurred on November 27, at 11h. 8·5m. M.T. at Athens. Of Ceraski's variable U Cephei, a minimum took place May 13, at 11h. 0·2m., and one on November 26, at 9h. 4·1m.—the interval corresponding to 79 periods of 2d. 11h. 49m. 25s. A minimum of Mira Ceti (a phase of which we have comparatively few observations) occurred on March 2. χ Cygni attained a maximum July 17·0, brightness 6·5; this date is nearly three months later than the epoch assigned by Argelander's formula in the seventh volume of the Bonn Observations, as indeed has been the case for some years. For Pigott's variable R Scuti, Prof. Schmidt finds maxima at August 7·2 and October 31·2, and minima at July 4.9 and September 23·6. He has many epochs for the short-

period variables, δ Libræ, δ Cephei, β Lyræ, η Aquilæ, and ζ Geminorum.

THE TOTAL SOLAR ECLIPSE OF MAY.—The central line in the eclipse of May 17 passes near to Teheran, in which longitude the duration of totality will be within five seconds of the maximum. Taking the position of the Indo-European Telegraph Station in longitude 3h. 25m. 41·7s. east of Greenwich, and latitude 35° 41′ 7″, as determined by the Russian General Stebnitsky, it appears that the central line will pass between nine and ten English miles south of the station. At Shanghai, the eclipse is partial, magnitude 0·996 at 5h. 21m. p.m. local mean time: the central line runs some fifteen or sixteen miles north of that place: the sun at an altitude of 17°. At the observatory of Zi ka-Wei, the eclipse is also partial, magnitude 0·994. In Cairo, upwards of nine-tenths of the sun's diameter are covered.

GALLE'S METHOD FOR SOLAR PARALLAX.—The present year will afford two favourable opportunities of applying the method suggested by Prof. Galle for determining the sun's parallax, viz. the observation at distant stations of the minor planets when they approach near the earth. Mr. Gill has taken steps to secure such observations about the opposition of *Victoria* on August 24, and that of *Sappho* a month later. In the case of the former, the distance from the earth at opposition will be 0·891 (the earth's mean distance being taken as unity), the declination 8° N., and the magnitude 8·3; in the latter case the distance will be 0·847, the declination 12½° N., and the magnitude 9·2. Ephemerides of both planets about opposition will be found in the *Berliner Astronomisches Jahrbuch* for 1883.

THE TEMPLE OBSERVATORY, RUGBY.—We have received the Report of this Observatory for the year 1881. As in former years, the principal instrument, an 8¼ inch refractor by Alvan Clark, has been employed on observations of double stars, and 210 complete sets of measures of distance and position were made in the past year. Mr. Seabroke, the honorary curator, with the assistance of Mr. Hodges, has completed a summary of the work in the three years 1878-80, which forms part of vol. xlvi. of the *Memoirs* of the Royal Astronomical Society recently issued. Some attention has been given to the determination of the motion of approach or recession of stars, though with the double-star work and the hour each fine evening, through part of the year, devoted to members of the school, little time remains for that class of observation, more especially as the observers engaged follow their ordinary vocations during the day, and very late hours are thus precluded.

GEOGRAPHICAL NOTES

THE mail from India brings the news of the death of a very meritorious Indian servant, and one of the most remarkable of living travellers—Nain Singh, or the Pundit No. 9, as he was officially known, a hillman of the Khsettriya, or warrior caste. Nearly thirty years ago he offered his services as native assistant to that intrepid but unfortunate explorer Herr Schlagentweit. In the year 1863 he became one of the staff of trained native explorers under the orders of Col. Montgomerie of the Trigonometrical Survey, and it was in this capacity that he earned his reputation. The experience which Nain Singh had acquired with Herr Schlagentweit was held peculiarly to fit him for employment in the most interesting department of Indian geographical research—the exploration of the Trans-Himalayan regions. The success which attended his journeys beyond the great northern mountain barrier of India exceeded the expectations of even the talented officer who had specially trained him for the work. In 1866 he determined the true position of Lhasa; in 1867 he visited the celebrated gold mines of Thok Jalung, and seven years later he began his most celebrated tour of all, that through Thibet from west to east. During this he visited the capital of the Dalai Lama, took numerous observations, and threw much fresh light on the question of the Sanpu River, and whether its lower course is the Brahmapootra or not. This exploit closed Nain Singh's public career. He was awarded the Royal medal by the Royal Geographical Society, and the Indian Government granted him a small estate, where he died towards the end of last January. There have been few native Indian officials who have done more useful or more durable service than the explorer Nain Singh.

AT the meeting of the Geographical Society on Monday Mr. H. W. Fresfield, the secretary, read a paper on a three months' journey in the Makua and Lomwe countries, by Mr. H. E. O'Neill, who succeeded the late Commander Musters as consul at Mozambique. Mr. O'Neill evidently made a very successful journey of 600 miles through country previously almost unknown, and his paper forms a contribution to geography which is of some importance, though it hardly comes up to our ideas of what a good geographical paper should be. The most telling part of it is that which deals with the manners and customs, &c., of the Makua race. Though it has been reported that Mr. O'Neill actually sighted the Wamuli Peak, said by the natives to be covered with perpetual snow, he himself distinctly says that, although its position was pointed out to him, he could not clearly distinguish it. To some future traveller, therefore, will fall the honour of actually being the first to *see* the snow-clad peak, if it really exists, though no doubt he will have been very nearly run by Mr. Maples on one side and Mr. O'Neill on the other. Towards the conclusion of his paper, Mr. O'Neill makes some useful observations on the commercial capabilities of the country traversed, from which it would appear that there is a good opening there for imports, but the economic products are at present few.

THE most important contribution in the March number of the Geographical Society's *Proceedings* is Mr. Last's account of his journey from Mamboia into the Nguru country, East Central Africa. On this occasion Mr. Last had his wife with him, and travelled, in a little over three weeks, some 250 miles, of which the whole of the region between Mguru and Kibanti was new to Europeans. Mr. Last sent home a rough map of his journey, on which he also laid down the roads and places passed in 1880, as most of them are not shown on previous maps of East Africa, and from this a map on the scale of nearly twelve miles to the inch has been prepared. There is an interesting note referring to Diego Garcia, the most southerly island of the Chagos Archipelago, and others on Mr. Colquhoun's expedition through Southern China and Burmah, and the journey of MM. Bouvalot and Capus from Bokhara to Krasnovodsk. The full text is also given of Lieut. A. W. Greely's report on the proceedings of the expedition to Fort Conger, Grinnell Land, the name he has given to the first of the international meteorological observatories in the Polar area.

THE Geographical Society have now ready for issue by Mr. Murray, Mr. E. Colborne Baber's "Travels and Researches in Western China," forming the first part of their *Supplementary Papers*, a publication which is to take the place of their annual *Journal*. The staple of the volume consists of Mr. Baber's journey of exploration in Western Szechuen, accompanied by various scientific observations and tables of latitudes and longitudes of numerous positions. The remainder of the volume contains reprints of a brief narrative of a journey to Ta-chien-tu, and notes on the route of the Grosvenor mission through Western Yünnan and on the Chinese tea-trade with Tibet. The maps are of great value, and consist of one showing the distribution of the Sifan tribes, a section of country along Mr. Baber's routes, and a large route-map of his explorations in Western China.

THE two last numbers of the *Izvestia* of the Russian Geographical Society contain a good deal of valuable information. M. Pevtsoff contributes a paper on his journeys in Mongolia, from the Altai to Kobdo, Kukukhoto, Kalgan, and back, *viâ* Urga and Ulasutai, with a map of the country; Dr. A. Woeikoff gives a *résumé* of the amount of cloud, observed during ten years' observations in Russian meteorological stations; A. E. Regel contributes a paper on his journey to Turfan in 1879; Lieut. Kalitin gives a description of the region explored between Akhalteke and Khiva, with a map; and MM. Yadrintseff gives an interesting account of the Tartars of Altai. There are, besides, a letter of A. W. Adrianoff, on his expedition in the Kuznetsk region, a list of heights determined by M. Potanin in Mongolia, information about the expedition of the *Jeannette*, of the *Alliance*, of the *Thomas Corwin*, and other small notices.

THE Russian Geographical Society is taking part in an expedition to Central Africa, under the leadership of M. Schultze-Ragozinsky, and with the participation of M. Bianchi, Prof. Licati, M. Budilovitch, of the Russian navy, M. Bartoshevitch, of the St. Petersburg University, M. Tomsen, Windakovitch, and several others. The expedition proposes to explore the little-known parts of Equatorial Africa, between 1° and 10° N. lat., and 10° to 12° E. long. The expenses will be defrayed

from a special fund subscribed by the members of the expedition, and amounting to 10,000*l*.

WITH the beginning of the present year the Geographical Society of Paris have begun to issue a fortnightly *Compte Rendu* of their proceedings, published within ten days after their meetings. A quarterly volume will also be issued containing memoirs and other papers of some length. This is a great improvement on the old *Bulletin*, which was often months behind date. The Society now numbers upwards of 2150 members.

WE may remind our readers that Mr. Edmund O'Donovan, so well known as the *Daily News* correspondent in the Trans-Caspian region, and more particularly at Merv, will read a paper before the Geographical Society, on March 27, on the geography of Merv and the surrounding country. The meeting will, we believe, be held as usual in the theatre of London University, at Burlington House.

AT the last meeting of the Geographical Society of Paris, M. Achille Raffray, Vice-Consul at Massowah, read an interesting paper on his journey in Abyssinia, and in the country of the Raya Gallas. It was announced during the evening, that one of the Society's gold medals had been awarded to M. G. Revoil, for his journeys in Somali-land, and another to Dr. Lenz, for his recent journey to Timbuktoo, the Logerdt prize medal to Dr. Montano, for his explorations in the Malayan Archipelago, and the new Jomard prize to Prof. Gaffarel, for his services in the cause of historical geography.

DIRECT news from Lieut. Bove, the leader of the Italian Antarctic expedition which started from Buenos Ayres, has been received in Italy. The expedition was most hospitably received at Buenos Ayres. The Government of the Argentine Republic has sent out a commission with the Italian Expedition for the purpose of carefully revising the survey of the coast of their country; thus the expedition now consists of four ships, viz. *Santa Cruz*, *Uruguay*, *Cape Horn*, and a steam barque. The *Cape Horn* is the largest vessel, and will proceed to the Antarctic regions, while the *Uruguay* will remain at Cape Horn. The *Santa Cruz* will attend to the coast survey. The expedition started on November 8, and Lieut. Bove hoped to leave Cape Horn by the end of December in order to sail across to South Shetland and Grahamsland. He hoped to be back at Tierra del Fuego by the end of March, to stay there till May, and then to leave for Buenos Ayres.

ON THE ELECTROLYSIS OF SULPHATE OF COPPER[1]

THE immediate object of this research was to examine various conditions connected with the transmission of electric currents through solutions of salts of copper, and to ascertain the influence of those conditions on the electro-chemical equivalent of copper, also to observe for any signs of conduction of electric currents by such liquids without electrolysis. In many of the experiments some difficulty was experienced in ascertaining the exact loss of weight of the anode, in consequence of finely-divided copper falling from it. The powder which fell off, exposing as it did a large surface to the liquid, was somewhat oxidised, and also in acid solutions freely dissolved, and its true weight, and therefore the exact loss of the anode could not be found.

Amongst the results obtained were the following:—that a porous partition in a solution of sulphate of copper affected the deposit only by preventing the products set free at the two electrodes becoming mixed together; a large surface of cathode diminished the amount of deposited metal, by allowing more copper to be re-dissolved by ordinary chemical action; the effect of diluting the liquid with sulphuric acid was to slightly diminish the amount of deposited copper; diluting the solution either with water, glycerine, propionic acid, solution of sulphate of sodium, borax, boracic acid, or of ammonic alum, had very little effect (and that variable) upon the amount of deposit; much less copper is deposited per unit of current in a hot liquid than in a cold one; without the influence of an electric current, a copper plate dissolved fifty-six times faster in an ordinary depositing solution of sulphate of copper at 180° F. than at 50 F.; the amount of copper deposited by aid of a current in such a liquid at 50° F. was about 18 per cent. greater than at 180° F.; with an electric current of small density, and a sufficiently corrosive liquid containing a very small amount of dissolved copper, no deposition of copper takes place; instead of an electric current protecting a copper cathode from chemical corrosion, it indirectly increases that corrosion; a sufficient rise of temperature (viz. from 50 F. to 180° F.) was nearly twice as influential as the electric current in increasing purely chemical corrosion; the purely chemical corrosion of a copper anode in ordinary sulphate of copper-depositing solution, is less than that of a separate piece of copper without a current; the loss of the anode is greater than the gain of the cathode in nearly every instance, and this difference is slightly greater with near electrodes than with distant ones; reduction of temperature is a most influential circumstance in diminishing the chemical corrosion of the two electrodes, and making their alterations of weight, by electrolytic action, approximate to each other; purely chemical corrosion of the copper is not entirely prevented by using a pure and cold solution not containing any free acid; the inequalities of loss and gain of the two electrodes are largely, if not wholly, due to purely chemical action; there exist relative degrees of chemical corrosive power and strength of current, at which the influence of the two are equal, and a copper cathode neither dissolves nor receives a deposit in an acidulated solution of sulphate of copper containing a very small amount of dissolved copper salt; the amount of copper deposited is not sensibly affected by the presence of a small amount of green sulphate of iron in the solution; nor by the exposure of such a solution freely to the air or to the light; differences of relative position of the electrodes to each other affect slightly both the amount of total loss of the anode per unit of current, and also the relative amount of such loss to the amount of gain of the cathode; the presence of a considerable quantity of persulphate of iron in the solution affects perceptibly the amount of deposited copper, but that of a moderate proportion of nitrate of copper in the solution had no conspicuous effect of the kind; the chemical corrosion of sheets of copper in pure acidulated solution of sulphate of copper was not directly proportionate to their amount of surface, but was relatively less upon the larger surface; the amount of copper deposited per unit of current did not vary much with the magnitude of the cathode or the density of the current; a very feeble thermo-electric current caused a cold copper anode to lose a little more, and a hot cathode to lose slightly less, than without the current; stirring the solution increased slightly the loss of weight of the anode per unit of current, and diminished to a small extent the gain of the cathode; stirring a pure acidulated solution of sulphate of copper increased the proportion of loss of weight of copper by ordinary chemical corrosion without an electric current from ·07 grain to ·17 grain, or from ·411 to 1·0, but in a less proportion if a current was entering the copper as a cathode; a considerable degree of density of current appears to be favourable to enabling a nearer approximation to be made to the true electro-chemical equivalent in the weight obtained of deposited copper.

Many of the experiments indicate, and the whole of them are consistent with the general inference, that in nearly all cases of electrolysis, the two forces, ordinary chemical and electro-chemical, coexist and operate independently at the same surfaces of liquid and metal; that ordinary chemical action, both of simple oxidation and of corrosion of both electrodes by free acid, takes place in all cases, and is a phenomenon essentially distinct from, and independent of, electro-chemical corrosion of the anode, and deposition upon the cathode. The two classes of phenomena, however, are coincident, and affect each other in various indirect and secondary ways.

In consequence of these two actions being essentially distinct and independent of each other, an electric current passing out of a piece of copper into an acid solution does not directly increase the rapidity of ordinary chemical corrosion of the metal, nor does a current entering from such a liquid into a copper cathode, protect in all cases that metal from such corrosion.

Some of the experiments show that stirring the liquid increases the ordinary chemical corrosion both of the anode and of the cathode, and therefore that the technical process of swaying to and fro by mechanical means, articles which are being plated in a depositing solution, tends to corrode them.

That temperature also greatly influences the chemical corrosion is proved by the numerical results. The higher the temperature the greater was the amount of chemical solution of the hot copper without current, and of the hot electrodes; and for equal rise of temperature, the increase of corrosion appeared to be

[1] Abstract of a paper read before the Birmingham Philosophical Society, January 26, 1882. By G. Gore, LL.D., F.R.S.

greater at high temperatures than at low ones, because the corrosion itself produced heat.

A considerable deficiency of deposited copper, sometimes amounting to 18 per cent., may result by ordinary chemical corrosion through employing a hot solution. This fact is worthy of consideration in the electro deposition of copper for commercial purposes.

The greatest obstacle to finding the electro-chemical equivalent of copper was the difficulty of determining how much the ordinary chemical corrosion was decreased at the anode or increased at the cathode by the electric current, and the next greatest obstacle was the disintegration of the anode, and the dissolving of the powder by chemical action. Notwithstanding that the cathode is more corroded by purely chemical action than the anode, the gain of weight of the former is the least inaccurate, because of the unavoidable disintegration of the anode. Substantially the method does not admit of a great degree of accuracy, because the chemical corrosion of copper, even in a cold neutral solution of cupric sulphate, causes a loss of that metal, and prevents the true weight being obtained. The correction cannot be accurately, but may be approximately, found, by using a comparison sheet of copper in the same liquid without a current. The corrosion of such a sheet is, however, somewhat less than that of the cathode. The nearest approach to the true number appears to be obtained by using a cold neutral solution, small narrow horizontal electrodes, and rapid deposition without stirring, continued during only a short period of time.

No signs were observed in any of the experiments of ordinary electric conduction unattended by electrolysis.

The results of this research also afford information respecting the degree of accuracy of the method of measuring by means of electrolysis of a solution of cupric sulphate, the amount of electric current consumed in electric lighting, and states the conditions under which the degree of inaccuracy of such a method of measurement is the least. It is a remarkable circumstance that an electric current entering a copper cathode from a strong mixture of sulphuric acid and water, instead of protecting the copper, actually increases its chemical corrosion; by what means it does this is now being investigated by the author.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

Oxford.—The examiners for the Burdett-Coutts Geological Scholarship have recommended for election Mr. G. A. Buckmaster, B.A., of Magdalen College. Mr. R. Chalmers, B.A., of Oriel, also distinguished himself in the examination. The scholarship is tenable for two years.

Cambridge.—Notice has been given that one of the Cambridge local examinations will be held in September next, commencing on Monday, 4. This is, partly, for the convenience of students who desire to pass a preliminary examination required by the General Medical Council previous to registration as medical students. Many students used to resort to the College of Surgeons for this purpose, but the College has ceased to hold such an examination, and it is at the instance of the Medical Council that a local examination is to be held in September for the accommodation of the medical students. The examination is also intended to enable students who intend entering the University in October to obtain, before going up to Cambridge, the certificates which will excuse them from the previous examination of the University. They will find it a considerable advantage to do this, for, in addition to the time so gained, having gone through the required test of school education through the local examination in September, they will be able at the beginning of the October term to join the classes of the several professors (of natural science, medicine, and others) at the commencement of the several courses. Hitherto many passed the previous examination in December, and many at a later period. Now the arrangements are such that all have the opportunity, through the Oxford and Cambridge Schools Board Examination in June, or through the local examination in September, of obtaining certificates which will wholly, or partly, exempt them from the previous examination; and it is obvious that those who take the advantage of this opportunity will have the start of their fellows in the University race. The September examination will be held on September 4, in Cambridge and London, and other places in which there may be sufficient candidates. The requisite forms to be filled up and sent in before August 1, may be obtained, with other information, for Cambridge, from Rev. G. F. Browne, St. Katharine's College; and for London, from Mr. R. Sc. J. Corbet, 10, Portman Street, London, W.

Prof. Humphry announces that Mr. Donald McAlister will give a course of lectures on the Mechanics of the Human Skeleton in the Easter Term, beginning on Wednesday, April 26.

The Cambridge University Natural Science Club celebrated the tenth anniversary of their foundation by holding a dinner in the hall of Downing College (kindly granted for the occasion) on March 11. Dr. Michael Foster, Sec.R.S., occupied the chair, and there was a large gathering of old and present members and their friends. It is worthy of note that seven Professorial chairs in science and ten Fellowships, besides other dignities, are at present occupied by former members of the Club in the short time that has existed since its foundation.

Victoria University.—The Council have appointed the following as external examiners of the University:—In Classics, the Rev. R. Burn, M.A., Fellow of Trinity College, Cambridge; In English Language and Literature, Mr. T. C. Snow, M.A., Fellow of St. John's College, Oxford; in French, M. E. Joël, Mason College, Birmingham; in German, Prof. C. A. Buchheim; in Philosophy, Mr. James Sully, M.A.; in Political Economy, Mr. W. H. Brewer, M.A.; in Mathematics, Mr. John Hopkinson, M.A., D.Sc., F.R.S.; in Engineering, Mr. John Hopkinson, M.A., D.Sc., F.R.S.; in Physics, Prof. A. W. Rucker, M.A.; in Chemistry, Prof. H. E. Armstrong, F.R.S.; in Physiology, Mr. J. Langley, M.A., Fellow of Trinity College, Cambridge; in Zoology, Mr. Patrick Geddes, Demonstrator in Botany in the University of Edinburgh; in Botany, Mr. S. H. Vines, M.A., D.Sc., Fellow of Christ's College, Cambridge; in Geology and Palæontology, Prof. T. Rupert Jones, F.R.S.

SOCIETIES AND ACADEMIES

London

Zoological Society, February 12.—Prof. W. Flower, LL.D., F.R.S., president, in the chair.—Mr. F. Moore read a paper containing an account of the Lepidoptera collected by the Rev. J. H. Hocking, chiefly in the Kangra district, North-west Himalaya, with descriptions of new genera and species.—A communication was read from Mr. G. A. Boulenger, C.M.Z.S., in which he gave the description of a Frog (*Phyllomedusa hypochondrialis*) lately living in the Society's Gardens. This Frog had been obtained at Pernambuco, and was believed to be the first example of the species that had reached Europe alive. Attention was drawn to the peculiar coloration, as being worthy of notice, it not having been described before.—Mr. Oldfield Thomas read a paper containing the descriptions of a small collection of Rodents which had been obtained by the late Mr. B. J. Andersson in Damara Land and in the neighbouring countries. The collection contained examples of a new species of Mouse, which was proposed to be named *Mus nigricauda*.—Mr. W. A. Forbes gave a description of the pterylosis of *Mesites*, and made some remarks on the position of that genus, which he considered to be most nearly allied to *Rhinochetus* and *Eurypyga*, though all these three forms should be referred to different families.—Prof. St. George Mivart read a series of notes on the anatomy of the Canada Porcupine (*Erithizon dorsatus*).

Chemical Society, March 2.—Prof. Roscoe, president, in the chair.—The following papers were read:—On the action of aldehydes on phenanthraquinone in presence of ammonia (third notice), by F. R. Japp and F. W. Streatfeild. With aldehydes of the benzene series and furfuraldehyde, compounds belonging to the class of substances obtained by Ladenburg (*Ber.* ix. 1524) were obtained; with hydroxyaldehydes of the benzene series, compounds of the character of the anhydrobases described by Hübner were formed; with the methyl ether of salicylaldehyde a mixture of both the above bodies is obtained. The authors conclude that the above reactions are most readily accounted for on the assumption that phenanthraquinone has the peroxide constitution ascribed to it by Graebe.—Application of the aldehyde and ammonia reaction in determining the constitution of quinones, by F. R. Japp and F. W. Streatfeild. The authors state that the occurrence of this reaction and the formation of compounds resembling those above described, may be taken as a proof of the ortho position in quinones.—On the solubility of glass in certain reagents, by R. Cowper. The author has determined the quantity of matter dissolved out of glass by ammonium

sulphide and ammonium hydrate; dilute solutions have more action than the concentrated reagents.—Analysis of a piece of oxidised iron from the condenser of H.M.S. *Spartan*, by R. Cowper. This contained no metallic iron, but 42·33 per cent. of ferrous oxide, 2·21 per cent. of ferric oxide, 5·24 per cent. phosphoric acid, 2 per cent. chlorine, and 16·71 per cent. water. Under ordinary circumstances iron rust is chiefly composed of ferric oxide.—On the action of sodium hydrate and carbonate on felspars and Wollastonite, by W. Flight. The hydrate acts powerfully as a solvent, but the strongest solutions of the carbonate have but little action.—On the preparation of pure nitrogen, by W. Flight. The author finds that ferrous oxide, freshly precipitated by adding caustic potash to ferrous sulphate solution, completely deprives ordinary air of oxygen; potassium pyrogallate and other reagents do not remove the last traces of oxygen.—Some observations on the luminous incomplete combustion of ether and other organic substances, by W. H. Perkin. When, in the dark, a jet of ether is blown from a wash-bottle on to an iron plate at a dull red heat, a lambent blue flame is observed, the temperature of which is so low that it does not char paper; a similar flame is seen when a heated iron ball is suspended over a dish of ether. Sir H. Davy, Doebereiner, and Boutigny, have noticed this phenomenon. Spermaceti, when melted over a hot iron ball shows a similar phenomenon. Paraffin, alcohol, &c., also give a blue flame when treated as above.

Mathematical Society, March 9.—S. Roberts, F.R.S., president, in the chair.—Mr. A. Buchheim, B.A., Scholar of New College, Oxford, was elected a Member.—The following communications were made:—In how many ways can a polygon of $2n$ sides be divided into quadrilaterals by means of non-intersecting diagonals with an extension to the general case of division into p-gons? Prof. Rowe.—Systems of formulæ for the *sn*, *cn*, *dn* of $u+v+w$, Prof. W. Woolsey Johnson (communicated by J. W. L. Glaisher, F.R.S.).—Remarks on the preceding paper, and on elliptic function formulæ, Rev. M. M. U. Wilkinson.—Two notes, Mr. C. E. Bickmore.—Note of proofs of the addition theorem for the second integral, and Fagnani's theorem by confocal conics, J. J. Walker.

Linnean Society, March 2.—Sir J. Lubbock, Bart., F.R.S., in the chair.—The following gentlemen were elected Fellows of the Society, viz.:—Col. R. H. Beddome, T. B. Chambers, Rev. W. H. Dallinger, C. D. Ekman, W. Fream, Rev. R. Hooper, C. Dubois Larbalestier, Rev. R. P. Murray, and R. Vipan.—Prof. P. M. Duncan showed an example of the pollen-tube of *Crocus sativa*, and he explained his views thereon.—Mr. Chas. Stewart also exhibited sections of the ovule of *Crocus*, and Mr. C. Fred. White likewise exhibited a series of drawings of the pollen of various plants.—D. T. Spencer Cobbold called attention to drawings of the pollen-tubes of *Portulaca oleracea*, &c., received from Mr. Krutschnitt, of New Orleans, U.S.—A paper on the structure and habits of the coal-reef annelid *Palolo viridis*, by the Rev. Thomas Powell, was read; the information regarding its periodic visits to Samoa and Fiti being of considerable interest.—Contributions to the Lichenographia of New South Wales, by Chas. Knight, was also read, some fifty new species of Lichens being described.—Mr. A. G. Butler gave a communication on the butterflies collected by Lord Walsingham in California; and Mr. R. B. Sharpes' seventh contribution to the ornithology of New Guinea, and a description of a new species of sand-martin (*Cotile*) from Madagascar, were read.—There followed a description of a new genus (*Microgale*), and two new species of Insectivora from Madagascar, by Mr. Oldfield Thomas.

Anthropological Institute, February 21.—Edward B. Tylor, F.R.S., vice-president, in the chair.—The election of W. Crowder was announced.—Mr. J. E. Price read a note on Aggri beads. These beads are occasionally dug up on the Gold Coast, and sell for more than their weight in gold, being among the most valued of royal jewels. They have been found in various parts of England, some of those exhibited having been obtained from Colchester, where they were found associated with human remains, whilst others were discovered during the recent alterations at Leadenhall Market. The author thought that the appearance of these beads in England might be accounted for by the fact, that when the Romans occupied the country they brought with them many African slaves who wore necklaces with Aggri beads attached, and that when these slaves died their necklaces were buried with them.—Dr. Macfarlane read a paper on the analysis of the relationships of consanguinity and marriage; and in the absence of the authors the director read a paper entitled from Mother-right to Father-right, by Mr. A. W. Howitt and the Rev. Lorimer Fison.

Geological Society, February 22.—J. W. Hulke, F.R.S., president, in the chair.—Richard Kerr, Baron Ferd. von Müller, K.C.M.G., M.D., Ph.D., F.R.S., William Whitehead Watts, and Joseph Wilkinson, were elected Fellows of the Society.—The following communications were read:—Additional discoveries of high-level marine drifts in North Wales, with remarks on driftless areas, by D. Mackintosh, F.G.S.—On some sections of Lincolnshire Neocomian, by H. Keeping, of the Woodwardian Museum, Cambridge, communicated by W. Keeping, F.G.S.—Notes on the geology of the Cheviot Hills (English side), by C. T. Clough, F.G.S.

Physical Society, March 11.—Prof. Fuller in the chair.—New Member, Mr. D. Reece Jones.—Mr. Newth showed some experiments illustrative of the fact announced by M. Mascart in 1875, that solid particles in the air are necessary to the formation of fogs; and secondly, that certain gases, such as sulphurous acid gas, also cause fogs in the same way, by permitting the moisture to condense upon these particles. The experiments consisted in passing an electric light beam through large bulbs of glass containing air and a small quantity of water. When the air in the bulbs was washed with the water, and thus freed from motes, the fog produced in the bulb by slightly exhausting it with an air-pump was much less than when the air of the room, or smoke, or sulphurous acid gas, was admitted into the bulb. The dust on a platinum wire, rendered incandescent within the globe by an electric current, also caused a sensible fog. It follows that with gas fires instead of coal, there would still be fogs, though not so black ones.—Prof. F. Guthrie, F.R.S., read a paper on the discharge of electricity by heat. This was concerned with additional experiments to those made by the author on the subject nine years ago. He showed by means of a gold leaf electroscope that a red-hot iron ball, when highly heated, would neither discharge the positive prime conductor of a glass electrical machine nor the negative one, but on cooling the ball a temperature was found at which the ball discharged the negative conductor, but not the positive one. Lastly, on cooling the ball still further (but not below a glowing temperature) it was found to discharge both positive and negative electricity. A platinum wire rendered red hot by the current also discharged a negatively-charged electroscope more readily than a positively charged one. When placed between two electroscopes, one having a + and the other a − charge, it discharged neither. When the + one was withdrawn the − was discharged; but when the − was withdrawn the + was not discharged. There therefore seemed a tendency in a hot body to throw out + rather than − electricity. That a material medium between the heated body and the electrified one was necessary, was shown by the failure of the experiment with a Maxim incandescent lamp consisting of a carbon filament in a vacuous bulb. Dr. Guthrie also showed the demagnetisation of a small magnet in the heat of a Bunsen flame by inserting it in a coil of wire connected to a mirror galvanometer and heating it in the flame. He also showed that the pole of a voltaic battery could be discharged by heating it red hot. This was done by connecting a piece of fine platinum wire to one pole and heating it in the flame of a spirit lamp, care being taken to insulate the lamp to prevent conduction to earth. The discharge was shown by means of a mirror electrometer.

Entomological Society, March 1.—Mr. H. T. Stainton, F.R.S., president, in the chair.—Mr. T. R. Billups exhibited queens of *Vespa germanica*, taken on the wing on January last, and specimens of *Callistus lunatus* and *Ichneumon erythræus*.—Mr. R. McLachlan showed papers in which butterflies had been received from Borneo, bearing an unusually distinct imprint of the inclosed insect.—Messrs. Meldola and Cowan called attention to the assembling of butterflies round pupæ.—Mr E. A. Fitch exhibited some eggs of Entozoa.—Papers read:—Mr. C. O. Waterhouse, a description of *Paramellon sociale*, a new genus and species of Myrmecophilous Coleopteron from India.—Dr. D. Sharp, on some New Zealand *Coleoptera*.—Mr. A. G. Butler, additional notes on *Bombyces* collected in Chili by Mr. T. Edmonds.—Mr. E. Saunders on the abdominal segments in aculeate *Hymenoptera*, and Sir S. S. Saunders on those in the *Chalcididæ*.

Edinburgh

Royal Society, February 20.—Prof. Maclagan, vice-president, in the chair.—Prof. Turner read a paper on a specimen of *Balænoptera borealis* or *laticeps*, which was captured in 1872 at Boness, on the Firth of Forth. Comparing this species with the other three species of Balænoptera, the author noted how highly characteristic of each were the number of vertebræ and the appearance of the whalebone. The skull, ribs, and other bones of the present specimen were of a peculiarly smooth texture as compared, for example, with those of *Balænoptera Sibbaldii*—indicating probably a less amount of oil in the bones of the former. The hyoid bone was particularly referred to as of a highly characteristic form.—Prof. Tait communicated a quaternion note by M. Gustav Plarr, on Minding's theorem.—Prof. Heddle presented chapter vii. of his chapters on the mineralogy of Scotland, dealing in the present instance with the ores of manganese, iron, chromium, and titanium. Two new ores of iron were described.—Prof. Tait communicated a paper by Mr. W. J. Millar, C.E., on the dimensions of cast iron at various temperatures, the greatest novelty in which seemed to be the conclusion, based on careful experiment, that the coefficient of linear dilatation of iron diminishes markedly with rise of temperature.—Mr. M. M. Pattison Muir, M.A., in a short chemical note, gave the properties of an oxycyanide of bismuth, and recorded the discovery of a new oxide, which he called the hypobismuthic oxide.—Mr. T. B. Sprague communicated an extremely neat and complete graphical representation of the well-known theorem, due to Cauchy, relating to the number of roots in an equation of the *n*th degree.—Dr. R. S. Marsden supplemented his former communication on the function of carbon in steel by a short paper on the influence of silicon (which behaves somewhat similarly to carbon), phosphorus, manganese, and other elements.

Paris

Academy of Sciences, March 6.—M. Blanchard in the chair.—The following papers were read:—On the normal carbonic acid of atmospheric air, by M. Dumas. After noticing the defects of several methods of measurement, he commends the exactness of M. Reiset's, and accepts his result, that about 3 vol. in 10,000 represents the general (little varying) ratio of CO_2 in air. The variations through great movements of the atmosphere now require study, by observers placed at many different and distant stations, and the transit expeditions should keep this in view. MM. Müntz and Aubin's methods are most suitable for this.—On some applications of the theory of elliptic functions, by M. Hermite.—Experiments on a Faure secondary battery, by MM. Allard, Le Blanc, Jaubert, Potier, and Tresca. The charging of the battery (formed of thirty-five elements, new model) required a total mechanical work of 1558 horse-power during 22h. 45m., or 1 horse-power during 35h. 26m. The battery really received only 0·66 of this work. 60 per cent. of the work of 6,382,100 kgm. thus stored was recovered in discharge (Maxim lamps being used). The use of the accumulator thus cost 0·40 of the work furnished by the dynamo. This loss would in many cases be outweighed by advantages.—On the double decompositions of haloid salts of mercury by hydracids and by haloid salts of potassium, by M. Berthelot.—On the formation of two dibasic acids, sebacic and suberic, in distillation of crude fatty acids by means of a current of superheated steam, by MM. Cahors and Demarçay.—Experimental studies on the action of permanganate of potash on poisons, forms of virus, and zymotic diseases, by M. Vulpian. The method can only be efficacious, he thinks, when the bite is very recent; in one hour, or more it must be useless, the permanganate (in the dose recommended) being unable to overtake the poison, and being soon decomposed. Intravenous injection of an efficacious dose of permanganate would be fatal.—Memoir on the generation and regeneration of the bone of caducous and persistent horns of Ruminants, by MM. Robin and Herrmann. They controvert the view that in the present case there is an exceptional form of osteogenesis, viz. *metaplastic* ossification, or direct transformation of cartilage into bone.—New pump for compression of gases, by M. Cailletet. A special feature is the presence of mercury above a plunger piston, with which the mercury moves. An hour's work will give 400 or 500 gr. of liquid carbonic acid or protoxide of nitrogen. The author stores compressed gases in bundles of metallic tubes communicating with each other, and each holding about four litres. Pressures of several hundred atmospheres are attained. The movement of the mercury in the pump counteracts heating.—Quick method of determining the density of gases, by M. Chancel. This depends (like M. Dumas' method for vapours) on displacement of the air of a spherical glass vessel by the gas whose density is to be measured, and which enters by a lateral tubulure in the neck, passing thence down a bent tube (soldered to the hollow stopper), which opens near the bottom of the vessel. At the proper time the stopper is turned, the supply tube (caoutchouc) detached, a cock above the stopper closed, and the vessel weighed.—M. Villarceau made some remarks in presenting a memoir on the methods of Wronski in celestial mechanics.—On rules to be followed in hypnotisation of hysterical persons, by MM. Dumontpallier and Magnin. This relates to the ways of producing each of the periods of hypnotism. To make a state disappear, one should use the same agent as produced it.—On the determination of the genus of an entire transcendental function, by M. Laguerre.—On the law of deviation of Foucault's pendulum, by M. Hatt.—On the compressibility of gases, by M. Sarran. He seeks to verify a relation given by Clausius, for other gases than carbonic acid.—On a vibratory movement in production of a steam jet, by M. Vautier. A plate placed across the jet at a certain height is repelled; but if lowered parallel to itself, it is attracted, and at about 0·2 mm. from the orifice it oscillates, with sound.—Hydrodynamic experiments (third note); direct imitation, with liquid currents, of the actions of electric currents on each other, by M. Decharme.—On the retrogradation produced by the electric *effluve* in transformation of oxygen into ozone, by MM. Hautefeuille and Chappuis. This change of ozone into oxygen is due to liberation of heat, accompanying the spontaneous destruction of ozone raised to a high temperature by the effluve; it occurs only at low pressures of oxygen.—On some phosphates neutral to litmus, by MM. Filhol and Lenderens.—On an isomer of orcine, lutorcine, by MM. Vogt and Henninger.—On the soluble and insoluble modifications of the ferment of gastric digestion, by M. Gautier.—Division of embryonal cells in Vertebrates, by M. Henneguy. These observations were on the ova of trout.—On the circulatory apparatus of starfishes, by MM. E. and J. Perrier.—On some types of Cestodes, by M. Moniez.—On the organisation of the mouth of *Dochmius* or *Ankylostomas*, *apropos* of parasites of these two genera found in the dog, by M. Magnin.—Diabetic endocarditis, by M. Lecorché.—Ophitic rocks in the Pyrenees; ages; relations with saliferous substances; origin, by M. Dieulafait.—Variations of temperature with altitude in the valley of the Seine during the period of high pressures in January, by MM. Lemoine and de Tréandeau.—A geological map of the Loire valley (scale $\frac{1}{100000}$), by M. Grüner, was presented.

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THURSDAY, MARCH 23, 1882

TECHNICAL EDUCATION

THE Second Annual Report of the City and Guilds of London Institute for the Advancement of Technical Education is one of great interest. It enables us, for one thing, to see what progress has been made since the issue of the first Report. There can be no doubt that, during the short period that this Institute has been in existence, it has begun effective work on a plan which will commend itself to and command the confidence of those interested in education. The movement has been started with vigour, and very soon we shall probably have a widespread system of technical schools all over the country. In London the City schools belonging to the Institute have been eminently successful, to judge from the increasing attendance, especially upon the physical and chemical classes of Professors Ayrton and Armstrong. The classes of Prof. Ayrton on "Electric Lighting and Transmission of Power" and "Electrical Instrument Making" have been so well attended that it has been necessary to make arrangements for providing additional tutorial assistance, in order that his students might receive the individual attention they require. During the past session, 551 tickets of admission to the evening classes on Technical Physics have been sold, showing a considerable increase on the attendance last year. Dr. Armstrong, Professor of Technical Chemistry, has given special instruction in the subjects of "Coal Tar Distilling" and "Spirit Rectification." The number of tickets sold has been 265. Considerable progress has been made in providing suitable new buildings for these schools, and in adding additional means of instruction and practical laboratory work. Professors Ayrton and Armstrong have been inspecting some of the best technical schools on the Continent, with a view to assist them in organising the institutions in London. Last summer, moreover, the foundation of the great Central College was laid by the Prince of Wales, who is now President of the Institute, at South Kensington, and its construction is being actively proceeded with. In this college, as the Lord Chancellor stated on that occasion, from which the entire work of the Institute will be directed, instruction of a higher and more advanced character will be given, adapted to the wants of those who will be engaged in professional or commercial pursuits, in which a knowledge of some branch of mechanics, physics, or chemistry, in its practical applications, will be found, not only serviceable, but almost indispensable. The building, when completed, will be supplied with laboratories in which the most delicate operations may be carried on; with workshops in which the various branches of mechanical and electrical engineering will be taught; with studios in which applied art may be practised, and with lecture-theatres, and class-rooms in which the principles of science will be explained.

We see from the Report that the candidates for the Institute's certificates and diplomas have greatly increased during the last year. While in the year 1880, 816 candidates were examined in 85 centres, of whom 515 passed; in 1881, 1563 candidates were examined, some of them in two subjects, in 115 centres, of whom 895 passed, 66 of these passing in two subjects. Of the 895 successful candidates, 466 obtained the full certificate, having already passed in pure science as well as in technology. According to the new regulations, the science qualifications for the honours grade are raised, the candidate being required to produce *two* certificates in the *advanced* stage of the Department's examination. The Council attach so much importance to the preliminary training in pure science, that they look forward to the time when they will be able to require all candidates to adduce evidence of adequate scientific knowledge before being admitted to examination in technology. It was thought that the alterations in the regulations might possibly have the effect of lessening the number of students in attendance at the registered classes of the Institute during the present session; but so far is this from being the case, that whilst, according to the returns received in November, 1880, the number of students preparing for examination at 78 centres did not exceed 2500, the returns, received at the central office in November last, show that over 3300 candidates are now receiving instruction in 29 subjects at 115 centres. All this is very gratifying, for unless the candidates undergo a really testing examination both in the principles and practice of their art, unless care be taken to see that practical knowledge is based on a knowledge of scientific principles, we shall be no better off than before, but probably worse. Moreover a considerable increase is shown in the number of teachers who have been placed on the books of the Institute. The new rule which comes into operation after March 30, and which requires, except under special conditions, the candidate to have obtained the Institute's full certificate in honours in order to be registered as a teacher, will, doubtless, prevent the rate of increase of teachers from being as great in the future as it has been during the past two years. But the Council rightly feel that the success of the work in which they are engaged depends, to a great extent, on the efficiency of the teachers who are associated with it, and they think that the time has now arrived when they are justified in requiring from those who wish to be registered as teachers such evidence of their qualifications to impart technical instruction as is furnished by the Institute's Honours certificates, or by a strong recommendation from persons of recognised authority.

This is as it should be, and there is no doubt that the Institute will go on raising their examination standard, till it reaches the highest limit of efficiency as a test of knowledge of the principles and applications of science. The Institute is quite alive to the value of laboratory and workshop practice, and it does all it can to encourage and compel students not to rest content with mere book-knowledge, but to become familiar with the tools and processes themselves. The Institute is anxious to encourage the system in provincial schools, and so far as funds allow are willing to lend instruments for the purpose.

There is such evident anxiety to give both principles and practice equally fair play, that in drawing up the syllabuses of the several examinations the Council have availed themselves of the suggestions and co-operation of manufacturers; and with the view of making the examination a fair and satisfactory test of

the candidate's acquaintance with his subject, they have instructed the examiners to make the questions as practical as possible, and are endeavouring to secure the services of two examiners for each subject, one of whom at least shall be actually engaged in manufacture. At the same time it is interesting to notice that of those candidates who have not attended the ordinary registered classes, 47 in all presented themselves from University College, London; the Royal School of Mines; the Yorkshire College, Leeds; the Glasgow Technical College; the St. Mark's Technical College, Grosvenor Square; and from other similar Institutions; and of these 41 succeeded in passing, 23 in the first, and 18 in the second division, the percentage of failures being remarkably less among this than among any other class of candidates. Among changes in the technological examinations, all in the way of improvement, we may note that the subjects have been so arranged as to group together allied industries; examinations in electric lighting, the transmission of electrical energy, and electrical instrument making have been added; more sensible arrangements have been made as to the grades of the examinations; these and several other changes all tend to the efficiency of the examinations as real tests of the attainments of candidates.

From all this it seems clear that the Council of the Institute are impressed with the truth on which we have so often insisted in these columns, that there can be no efficient practice without sound principles, that instruction in the practical applications of science must be based upon a knowledge of the science which is applied, that instruction in the latter must precede instruction in the former, otherwise technical education is little better than the old empirical rule-of-thumb methods. Therefore we are glad to see, as the Lord Chancellor indicated in his speech at the laying of the foundation of the Central College last July, that the aim of the Institution will be to supplement the work of those institutions, especially the Science and Art Department, whose aim is to afford a knowledge of the principles of science and art. There is distinct evidence in the examinations of the new Institute of a gradual tightening of the tests, both for students and those who aim at being technical teachers. At the distribution of the prizes last December Sir Frederick Bramwell said that "the value of these certificates and prizes depends upon the thoroughness of the test that is applied, and it is in the interest of the certificate and prize-holders themselves that the standard of the examination should be maintained, in order that the value of the rewards may be duly appreciated. The Institute's certificates are intended to be regarded as diplomas of efficiency, and with this view they are awarded to those only who give evidence of possessing a practical as well as a theoretical knowledge of the subjects embraced by the examinations. Mere book-learning will not suffice to pass our examinations."

The City Companies have so far been wonderfully liberal in their donations to the Institute, but we hope those which have not contributed will take the advice of the Prince of Wales at the recent meeting, and lose no time in doing so. Compared with what has been spent in the Paris Conservatoire, the sum so far spent by the Institute has been a mere pittance; the City Guilds have ample funds at their command, and they could not spend them on a better object, or one more likely to yield a rich return for the benefit of London and the country generally than in an institution that we hope one day will be comparable to that of Paris. The success already achieved is a guarantee that money devoted to the purposes of the Institute will be well spent.

The Council of the Institute are even already hindered in their work from want of funds; all over the country opportunities occur for starting technical schools in important industrial centres, but this requires a little expenditure on the part of the Institute, to encourage an adequate response from local sources. It would indeed be extremely useful if, in connection with some more of the numerous science schools of the Science and Art Department, a technical School were available for those who desired to learn some of the practical applications of the principles they had learned at the science school. This would greatly help to impress upon the public the natural order of connection between the two departments. In the arrangement for awarding the Holl Scholarships and prizes in connection with the Institute, this order is insisted on, for, among other qualifications of the scholars, they must have passed an examination in mechanics (or physics), mathematics, and chemistry, to the satisfaction of examiners appointed by the Institute. All this seems to us very encouraging; the Institute is yet young, and technical education in the real sense is in this country only a thing of yesterday; but if it be developed along the lines indicated by this report, there is every reason to hope that in time it will become an Institution of the highest national importance.

THE ART OF DINING

Aristology; or, The Art of Dining. By Thomas Walker, M.A. With Preface and Notes by Felix Summerly. 8vo. Pp. 96. (London: George Bell and Sons.)

Food and Feeding. By Sir Henry Thompson, F.R.C.S., &c. 8vo. (London: Frederick Warne and Co.)

THE two dinners which stand out in our memory as events in our life were of very different characters. The one consisted of brown bread and lard, washed down with some rough country wine, and was eaten in the middle of a Tyrolese glacier. The other embraced every delicacy the heart could wish. Our appreciation of the first was due to compulsory fasting for some time previously. Our appreciation of the second was due to its intrinsic merit. In it the dishes seemed to be so arranged that each one stimulated the palate for the one that succeeded it, and the wines given with each course were so selected as to increase the appetite for, and appreciation of, the solids. We then, for the first time in our life, began to realise that cookery was a fine art. In speaking of the fine arts we generally include only those which appeal to the special senses of sight and hearing, such as sculpture, painting, architecture, music, and we rarely think of modes of appealing to the special senses of smell and taste. Yet the latter two are perhaps quite as closely connected with our emotions as the former, and as capable of exciting keen sensations of pain and pleasure. Smell and taste differ from sight and hearing in being much more easily fatigued, and this may partly be the cause of their imperfect cultiva-

tion. Another cause is, probably, the closer connection which smell and taste have with the process of nutrition, and the consequent alterations which repeated impressions upon them may have upon the general well being. A man may pass long hours in a picture gallery or concert room, receiving impressions good, bad, or indifferent, without much effect upon digestion or circulation, but a bad odour would quickly excite nausea or sickness. The impressionable natures of Southern Italy object to strong perfumes, even though pleasant. The sense of taste differs in one particular from the other three, viz. that while the agents which excite them may remain outside the body, the substances which excite taste are taken into the body, and thus have an action upon it independently of their mere effect upon the sense itself. In gratifying this sense, therefore, we have to consider not merely what will give the greatest pleasure at the moment, but what will be most satisfactory in its after results. Fortunately, pleasure to the palate usually aids digestion, if obtained in the proper way; but comparatively few people know the art of dining properly themselves, and still fewer know how to give good dinners to their friends.

The two works before us are intended to supply this lacking knowledge, both by giving general rules and special examples. Walker's "Aristology" deals more with the general rules of dining, and especially of dining as a social duty, and Sir Henry Thompson more particularly with the details of food and cookery. In discussing food, the latter author makes some very sound remarks regarding the excessive amount of butcher's meat eaten by Englishmen, and its injurious consequences. In the working classes it leads to wasteful extravagance, although the manual labour which they have to undergo may lessen its deleterious effect upon their health. In the upper classes, where its price has but little effect upon the purse, its injurious action upon the body is increased by want of exercise, and tends, as the author truly says, to shorten or embitter life. The food of middle class Englishmen might be rendered not only much more palatable, but much more healthy, by the introduction of larger proportions of fish, vegetables, and farinaceous substances, as well as by greater variations in the modes of preparation. Both these subjects are well considered by Sir Henry Thompson.

The question of the best combination of dishes in a meal, and the arrangement of the meals, next engages the author's attention; and after this he discusses the question of wines, coffee, water, and tobacco, gives a scheme for a dinner, and a number of *menus* for different months in the year, finishing up with suggestions for the improvement of public dinners, and for the better teaching of cookery and supply of food throughout the kingdom. The contents of Sir Henry Thompson's book thus corresponds to its title, "Food and Feeding," and it gives the elements of the dinner. Walker's "Art of Dining" aspires to a higher gastronomic level. It is written in a series of most readable little essays, in which the directions which concern the kitchen are omitted, and the foods are discussed as they appear upon the table. The key-note of the book may be found in the little sentence, "The chief maxim in dining with comfort is to have what you want when you want it," and in order to attain this the writer shows how the attendants should be ordered, and how the little adjuncts to the dishes should be arranged, so that no one shall have to wait for anything a moment after the desire for it has arisen. But more than this. It often happens that people do not know what to desire, and this the author tries to show them, by giving them illustrations of little dinners which he has had with his friends, and in which dishes and wines were so arranged in quantity and quality as to give the maximum of enjoyment. A puzzle in physics is the question whether a glass of water containing a cork would be heavier when the cork was fastened to the bottom of the glass or allowed to float on the water. The answer is that it would be heavier when the cork was at the top, because its place at the bottom of the glass would be taken by an equal bulk of water, which is heavier, and thus the attraction of gravity would act on the greater mass at the lesser distance. The author would apply a similar principle to the art of dining, and, instead of as usual keeping the delicacies until the last, when the appetite is palled by the previous dishes, he would give them first, when their enjoyment would be heightened by an excellent appetite.

"At a party of six persons, if the dinner consisted of soup, fish, a joint, and three woodcocks, I maintain it would be much better to serve the woodcocks before the joint, both on the score of enjoyment and of health—of enjoyment, because a delicacy, when the appetite is nearly satisfied, loses a great part of its relish, and is reduced to the level of plainer food whilst the appetite is keen—of health, because it is much more easy to regulate the appetite when the least tempting dishes are brought last. By serving delicacies first, people would dine both more satisfactorily and more moderately, and entertainments would be less costly and less troublesome."

This quotation may serve as an example of the book. To quote all that is worthy would be to transcribe the volume, and if it were read carefully and acted up to by every host, dinners would become a source of pleasure, instead of being, as they too often are at present, weary stale, and unprofitable.

OUR BOOK SHELF

Studies on Apus, Limulus and Scorpio. By E. Ray Lankester, M.A., F.R.S. (London: J. and A. Churchill, 1881.)

In these exceedingly clever memoirs we have a proof of how much can be made out of even well-known subjects by assiduous research, when combined with some speculative talents. The first memoir on *Apus cancriformis* is a valuable contribution to our knowledge of this most interesting Crustacean. The second on Limulus, an Arachnid, is even more interesting, and in its conclusions more startling, with it is combined a very elaborate comparison of the various systems of Limulus with those of Scorpio, and starting with the undoubted affinity of Limulus to the strange extinct Eurypterina, we have the suggestion that the Merostomata, including under this head the Xiphosura, the Trilobita, and Eurypterina diverged from the main stem of the Arthropod pedigree at a point between that indicated by the grade of organisation of Peripatus, and that occupied by the Pro-Phyllopoda or earliest Crustaceans, and it was in the time that these three great groups began to be formed, that each carried off with it some distinct evidence of their common departure.

The illustrations vastly assist in explaining the various technical details, and we are glad to see a large number incorporated in the text, thereby being rendered much

more easy of reference to the reader, than when relegated to plates at the end of a memoir.

Fashion in Deformity, as Illustrated in the Customs of Barbarous and Civilised Races. By William Henry Flower, LL.D., F.R.S., F.R.C.S., &c. With Illustrations. 8vo, pp. 85. (London: Macmillan and Co.)

If Prof. Flower by this little work has not rendered good service to medicine, and tended greatly to prevent the diseases due to the prevalence of absurd fashions, it is certainly not his fault. He discusses the curious fashion which has prevailed among all nations, of inflicting upon themselves serious pain and inconvenience, as well as rendering themselves abominably ugly, in their endeavours to conform to a false standard of beauty. He begins with the epidermal appendages—nails, hair, teeth, and skin, proceeding to alterations in the bony skeleton. After discussing the modes of dressing the hair, the first figure he gives is that of the hand of a Chinese ascetic, in which the finger nails appear to be nearly a foot long, and twisted almost like the tendrils of a vine. The custom of tattooing perhaps inflicts upon the votary of fashion more pain than almost any other. The process varies from making gashes with sharp stones, and rubbing wood-ashes into them, to pricking delicate patterns into the skin by pieces of shell cut into a number of fine points, or by a bundle of sharp needles, and then rubbing colouring-matter into the punctures. The custom of wearing rings and plugs in the lips, nose, and ears is sometimes carried to a most exaggerated extent, one man, in an island near New Guinea, having such holes in his ears, that the lobes were converted into great pendants of skin, through which he could easily pass his arms. Such deformities of fashion, although most disagreeable to our ideas, are of much less importance than those which affect the bony skeleton. The author gives a full description of the various modes of altering the shape of the head adopted by various tribes, and of deforming the foot amongst the Chinese. But from savage tribes, Mr. Flower passes on to deformity in fashion amongst ourselves. He shows, by drawings of deformed English feet, and of the modern Parisian shoe, that, much as we may ridicule the Chinese, we are very little better than they. In one particular, indeed, we may be said to be very much worse than either Chinese or savages, for, while they deform the foot, we deform that part of the body which contains our vital organs. How far removed from nature is the form imparted to the figure by fashion, is seen by comparing the figures of the Venus of Milo, and of a lady dressed in the fashion of 1880.

We fear that no amount of warning regarding the pain, suffering, and danger to life which such fashions entail, will ever prevent them from being followed; but it is possible that when fashionable people come to see that their absurdities reduce them to the same level of taste as a Botocudo Indian or Bongo Negro, they may be induced to seek after a higher standard, which shall at once be beautiful, and true to nature.

Cameos from the Silver-Land; or, The Experiences of a Young Naturalist in the Argentine Republic. By E. W. White. In two Volumes. Vol. I. (London: John Van Voorst, 1881.)

This is the first volume of an interesting work which would appear to give a true and vivid sketch of the great Argentine Republic as it is at the present day. The great Republic seems, by the test of the London Exchange, to be well holding its own, but the notions current in England about it are often absurd in the extreme. Mr. White has in this volume given us a very good guide-book to the province, detailing the chief peculiarities of its climate, giving an account of its various races, of the state of the education of the people in the province, and of its natural resources. Buenos Ayres is described in a very enthusiastic way, and the behaviour of its inhabitants is spoken of in glowing terms. The first few chapters are devoted to the experiences of our young naturalist in the large cities. When he left these for trips to Cordoba and such like distant places his experiences as a naturalist began, and we follow such wanderings with real pleasure. At one time he journeyed to Cosquin to hunt the Condor; again to Mendoza for the Guanaco; but wherever he went he was sure to observe and record some interesting incident about the flowers and birds and insects that he met with.

Select Extra Tropical Plants Readily Eligible for Industrial Culture or Naturalisation, with some Indications of their Native Countries and some of their Uses. By Ferdinand, Baron von Mueller, K.C.M.G., M.D., F.R.S. New South Wales Edition, enlarged. (Sydney: Government Printers, 1881.)

It would be difficult to convey an accurate idea of the large amount of information which the author has brought together within the compass of the 400 pages forming this volume, an edition of which was some years ago published by the Victoria Acclimatisation Society, and also not long since in Calcutta by the Central Government of India. While the present edition does not put in a claim for completeness, either as a specific index or as a series of notes on the respective technologic applicability of the plants enumerated, still, we have here brought together an immense assemblage of useful plants arranged in alphabetical order, but with a systematic index and also their correct scientific names, and the chief facts of interest that concern each as to its uses to mankind. Some of these plants, all of which are presumed to be capable of cultivation in extra-tropical countries, are good for food, either as yielding pot-herbage, or roots, or fruits. Others are useful for dyes, for their fibre, as fodder-plants, as medicinal plants, or as timber-trees. The information in all cases is given in the fewest possible words. Baron von Mueller is to be congratulated on the honourable part he has taken now for many years in enriching the culture-resources of his adopted country, and we echo his hope that this most valuable manual of useful plants may be placed in the leading library of every State school in the Australian colonies, when it will be sure to aid in educating the youth instructed therein, in a special knowledge that may be of immense service in the future of Australasia. E. P. W.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Vignettes from Nature

If Mr. Grant Allen does not mean what he says, I should strongly recommend him, alike for his readers' sake and his own, to say what he means.

When he wrote, "As a matter of fact, it seems probable that our *actual* fauna and flora are on the whole not only quite as big as any previous ones, but even a great deal bigger," and went on to cite the "modern" whales, the "living" forty-feet shark, and the elephants of the "recent period" (which not I, but his friendly reviewer, Mr. Wallace, converted into the "present time"), I naturally understood him to mean that the "actual," "modern," or "living" forms of these types are larger than any corresponding "extinct" forms of the same. It now appears, however, that he meant to include *extinct* whales, *extinct* sharks, and the *extinct* mammoth (with, of course, its contemporaries) as members of the "actual" fauna.

To me it seems far better that science should not be taught to

the public at all than that by the the use of the "vague but comprehensible language of ordinary life," such erroneous ideas should be propagated. I can assure Mr. Grant Allen, from no small experience of popular science-teaching, that the public mind is quite capable of drawing a very clear distinction between "living" and "extinct" animals, and would urge him to keep that distinction steadily in view in anything he may hereafter write on the subject.

With reference to the sharks' teeth brought up in the *Challenger* dredgings, in that part of the Pacific between Polynesia and South America, I may mention that only within the last week I have seen a collection of sharks' teeth from a "coprolite" digging in South America, among which was one of five inches by four, closely corresponding in its mineralised condition with the large *Challenger* teeth; and associated with them were rolled fragments of elephantine molars, presumably *Mastodon Andium*. And yet, according to Mr. Grant Allen, they belonged to our *actual* fauna!

W. B. CARPENTER

56, Regent's Park Road, London, N.W., March 20

Fisher's "Earth's Crust"

THE verdict of NATURE on the Rev. O. Fisher's "Physics of the Earth's Crust" is that "One or two points do seem to emerge from this assemblage of calculation as fairly clear and established on tolerably firm foundation. Such as that the contraction of the earth by cooling is inadequate to the production of its greater inequalities." . . That "there must be subterranean irregularities of density." I ask for a fresh trial on the ground that the evidence is insufficient.

On the first head, what Mr. Fisher has done is this. He has started with the assumption that no part of the earth became solid till the whole had cooled down to a uniform temperature of 7000° F. With this and some other minor assumptions he has been led to the conclusion stated above. And he has high authority on his side, for this is the assumption made by Sir W. Thomson in his well-known paper, "On the Secular Cooling of the Earth." But the facts that an assumption is not in itself physically impossible, and that it enables you to integrate a tiresome differential equation and obtain numerical results, are not sufficient to establish the truth of the assumption. There are other ways in which the earth may have passed from a fluid to a solid state, some of them, to say the least, quite as probable as that which Sir W. Thomson adopts. I very much fear then that Mr. Fisher cannot be said to have established even his negative proposition. Indeed, to my mind, Mr. Fisher's work seems rather to show that the earth did not consolidate in the way supposed by Sir W. Thomson.

The second point, strongly insisted on not only by Mr. Fisher but by many other eminent physicists, which the reviewer looks upon as finally settled, is the doctrine that the material of the crust must be denser beneath the ocean basins than beneath continents. The belief is grounded on the following argument. If this were not so, the preponderance of land on the northern hemisphere would attract the water, and the consequence would be that the sea-level would be higher in the northern than in the southern hemisphere. The answer is: How do we know that this is not so? At the outside the difference of level would not amount to more than a few hundred feet, and what is there to prove that the mean level of the sea in St. George's Channel is not a few hundred feet farther from the earth's centre than the mean level of the sea at the point diametrically opposite. It might be so, and we should none of us be a bit the wiser. The famous Indian deviation of the plumb-line, too, can hardly be looked upon as conclusive, when we reflect that it has been found capable of explanation in several ways by the ingenuity of the former Astronomer-Royal and the late Archdeacon Pratt. No problem that admits of several solutions can be appealed to as conclusive on a point like this. Mr. Fisher's treatment of the Revelations of the Thermometer cannot either be accepted as satisfactory. Any one who has roughly plotted to scale a section over the St. Gothard sees that a segment of a circular cylinder does not represent, even to a very loose degree of approximation, the contour of the mountain.

The reviewer speaks of the cause to which Mr. Fisher would assign the contortion of the rocks of the earth's crust as hardly adequate; he might have safely gone further. That cause is the injection of lava into fissures, or, in other words, the formation of dykes. That contorted rocks are often traversed by countless dykes is a well-known fact. Take for instance the dykes which seam so thickly the Palæozoic rocks of Scotland; but here the dykes were formed long after the contortions, and besides their general direction does not coincide with the longer axes of the folds into which the rocks have been bent. In other cases of violently-contorted rocks there is a striking absence of dykes; this is so along the coast of Glamorganshire and Pembrokeshire, where we have about the most marked case of intense folding and inversion in the British Isles. And this is still more strikingly the case in that marvellous example of contortion and inversion to be seen in the Canton of Glaurus, which has been so graphically described by Heim. Nowhere, as far as we know, on the earth's surface has inversion gone to the length it has here; dykes do traverse the Palæozoic rocks, but they none of them run up into the Secondary and Tertiary beds, and the contortion did not begin till towards the end of the Eocene period.

I for one should be only too relieved to think that some certainty, even if it were only of a negative kind, had been arrived at in the problems of the Physics of the Earth's Crust, but I fear we are a long way off this happy consummation at present.

A. H. GREEN

Yorkshire College, Leeds, March 14

An Equatorial Solar Spot

THE occurrence of a spot close to the equator is so rare a phenomenon that it may interest some of your readers to know that there is such a spot now on the disc.

On the 6th I noticed a spot, not long entered, and close to the equator; it was a large, well-defined, regular, oval spot, with a mag. axis exactly parallel to the sun's equator. On the 10th, at 10h. 45m. G. Astron. Time, this spot crossed the prime meridian, at a distance from the centre of the disc equal to 0·120 the radius, measured towards the true north limb, in the direction (156°–336°), *i.e.* parallel to the sun's axis.

This distance, 0·120 R., corresponds to hel. lat. 6°·9, measured from the centre towards the north; therefore, as the latitude of the centre is now 7°·2 south, the true hel. lat. of the spot is 0°·3 S.

The observations for determining the place of the spot were made on the 10th at 4.45, and on the 11th at 12.45; during the interval the spot had crossed the prime meridian, and the "position" of the axis of the spot, which had remained constant from the 6th till 4.45 on the 10th, had, during the interval, changed from (90°–270°), having reference to the sun's axis, to (38°-218°), *i.e.* 52° in 20 hours.

There was no further change from 12.45 to 4.45 on the 11th: and on the 12th the character of the spot was so altered that you could not distinguish any maj. axis at all. The instrument used was the $7\frac{1}{2}$-inch equatoreal refractor.

WENTWORTH ERCK

Sherrington, Bray, Co. Wicklow, March 13

Seasonal Order in Colours of Flowers

SIX years ago the question was brought forward in this journal (Vol. xiii. p. 427) whether light has any influence on the colour of flowers. I then called attention to the experiments made by Askenasy in 1875 (*Botanische Zeitung*, 1876, No. 1), from which he inferred that the action of light was different, some flowers being changed by darkness, but others not. Having myself from time to time studied this subject, I have seen, like other observers, that several kinds of pigment appear in complete darkness, but that in many of these cases daylight strengthens the tint and increases the hue. Not only flowers, but also other parts of the plant are thus affected. I found for instance that the shoots of several potatoes grown in the dark were coloured pink, that a bud of an elder-tree formed under the same circumstances two red-coloured internodes, and that crocuses, tulips, and hyacinths produced coloured flowers, whereas *Aucuba japonica* gave red-coloured fruits. It seems from the experiments that the plant is able to produce colouring matter without help from any source of light. But it is an important fact that the colours formed in the dark and those formed in the light often do not possess the same beauty. To prove this, I raised a bulb of hyacinth with two buds (or "noses" as they are called by Dutch florists); one of the two buds was covered by a piece of thick opaque paper to prevent the sun shining upon it, while the other bud was uncovered, and thus could enjoy the sun's influence. After some weeks the difference was very marked, the covered flowers being less intensively coloured than the others. This way of experi-

menting gave more striking results than that proposed by Askenasy, who kept the hyacinths in the dark until the whole inflorescence had opened, then cut off the upper part of the flower-stalk with half of the flowers and exposed it to daylight, while the others remained in their dark place. But he also saw that the latter flowers remained less coloured.

Experiments were also made by me with *Aucuba japonica*, which plant produced white flowers in the dark instead of purplish-brown ones in the light, just as the lilac does when cultivated in winter by florists. On the other hand, flowers of *Crocus vernus* and *Tulipa gesneriana* did not perceptibly change their colour. Among the leaves I experimented upon, I mention a Coleus which in the light produced green leaves with red lines, whereas the same sort gave in the dark yellow leaves with almost colourless lines. Achyranthes behaved very curiously, producing in the dark two normally coloured leaves, but the new-formed internode which supported them was almost white instead of red. This result calls to mind that of Batalin, who found ("Acta horti petropolitani," t. vi.) that plants of *Polygonum Fagopyrum*, which he had raised from seeds in the dark, were quite colourless, so that the difference from those grown in the light is very great, the latter, as is generally known, being of a dark red colour.

It appears from these examples, that those organs which are put into the dark in a very undeveloped state (so that they must much enlarge there) undergo much discolouring, whereas those parts that are hidden in a more advanced stage of growth, lose less colour, in some cases almost none.

Lilacs, for instance, develop in the dark from quite small studs, and so do flowers of Aucuba. Buck-wheat plants grow from small seeds containing a small hypocotyl, that enlarges afterwards to an exceedingly long part. The above-mentioned colourless long internode of Achyranthes came from a very small stud. In all these cases there can be only a small quantity of pigment (or chromogene) in the part before its development, and only this small quantity seems to be spread over the same part when many times enlarged. These cases, accordingly, render it very probable that light is necessary to increase the quantity of pigment, and that the pigment present, originates from the time when the plant was exposed to sunlight.

But tulips, hyacinths, crocuses, berries of Aucuba, &c. lose very little of their colour in the dark. Why is this? Because the buds of the flowers named, when hidden in the bulb are quite complete, and the green fruit of Aucuba had reached nearly their natural size at the time they were deprived of light. I think these flowers and fruits had already stored up a great deal of chromogene which they received from the leaves during the time when the bulb and the fruit were formed, just as they possessed a sufficient quantity of food to reach perfect development of all parts in the dark.

According to this opinion, the colour of a flower, fruit, leaf, &c. when grown in the dark, depends only on the quantity of colour-making matter or chromogene that is contained in the part at the moment when it is withdrawn from the light. This opinion is supported by an observation of Askenasy's (*Bot. Ztg.*, *l.c.*), who found that buds of *Pulmonaria officinalis* in different stages of development, when placed into the dark, got their colours the more perfectly the larger the buds were at the time of darkening. The buds which were smallest at that time exhibited almost white flowers.

My conclusion is then, that light is necessary for forming, if not the colouring matter itself, yet a matter (chromogene) which can easily pass into the pigment. J. C. Costerus

Amsterdam, March 12

The Electrical Resistance of Carbon under Pressure

I am indebted to Mr. Herbert Tomlinson for drawing my attention to his most interesting comparisons between the behaviour of carbon and of metals in respect of change of electric resistance under mechanical stress, and am glad to see that his delicate determinations entirely support my conclusion that the excessively slight change of specific conductivity produced by stress in hard coke carbon cannot possibly explain the great variations of resistance observed in the carbon telephone, carbon rheostat, &c. I have also learned that a similar conclusion was arrived at some time ago by Professors Naccari and Pagliani, and that some experiments made by Prof. W. F. Barrett of Dublin on the buttons of compressed lamp-black prepared in Edison's laboratory for use in his well-known carbon telephone lead to a precisely similar result. I am therefore perfectly willing to admit that before the publication of my experiments this question was virtually settled. It is quite clear that the carbon telephone does not work by any variation in the specific resistance of the carbon, but by the partial opening and closing of the circuit at certain surfaces where the intimacy of the contact can be varied by the vibrations.

Bristol, March 20 Silvanus P. Thompson

Vivisection

As I am named in your article thus headed (p. 429), I shall[1] be obliged if you will permit me a brief explanation of my position in regard to the question. There is doubtless in point of suffering a very great difference between such experiments on animals as those tabulated by Prof. Yeo (and cited in your article) and those common upon the Continent, and of which the horrible tortures perpetrated by Professors Schiff, Mantegazza, and Paul Bert may be taken as fair types. But I fail to see by what means, whether legislative or otherwise, the atrocities of vivisection are to be prevented, while its more moderate practices are to be permitted. Had the sins of the experimentalists been confined to the "hypodermic injection" of a few mice, as Sir James Paget has tried hard to make the public believe, I venture to assert that no outcry would ever have been raised on the subject. I for one should certainly have thought the cause unworthy of support. But the truth is, unfortunately, far otherwise. It is not against the inoculation of "vermin," or the pricking of a "tadpole's tail," that the indignation of the English people has been stirred, but against the prolonged and exquisite torments to which such highly sentient creatures as horses, dogs, and other domestic animals have been and still are subjected, often under the influence, not of chloroform, but of curare. So long as English physiologists continue to cite these things with approval, and openly to regret that the effects of public opinion in this country are such as to throw obstacles in the way of "free" and unlimited vivisection, as practised in the Continental schools, so long, I apprehend, the agitation deprecated in your article, will go on, and gather strength. It is the influence of public opinion only, which in this country finds expression as it does in no other, that has hitherto prevented the physiological laboratory of England from becoming as notorious a scene of horror as that of France, Italy, or Germany. And, let it be borne in mind, that the stir on this subject, which has expressed itself recently in the pages of various reviews and magazines, was set going by the demand of the Medical Congress for *unrestricted* vivisection. Sir William Gull's opening sentence in the *Nineteenth Century* of this month is, therefore, wide of the mark. Not less does he mis-state the case, when, in the course of his concluding observations, he infers that I bring against physiological research the charge of Atheistic tendency. That charge is distinctly made by me, not against legitimate research of any kind, but against a method which I wholly dissociate from "science" properly so called. And it is a charge not lightly made, but based on sound experience and thoughtful observation, unbiassed by "emotion" of any kind.

As it has not been my privilege to escape the customary personal retort of pro-vivisectors with regard to the wearing of fur, feathers, and the utilisation of animals, whether for food, pleasure, or clothing, I shall hold myself indebted to your courtesy for permission to make the following statement in justification of my own consistency:—I never buy furs, feathers, ivory, kid gloves, stuffed birds or other creatures. I have long been engaged in trying to introduce the use of vegetable leather for making boots and shoes, and have devoted much of my time to the question. I detest all "sport" which necessitates the pain and suffering of living creatures, and have written many articles and letters to various journals for several years past against seal-hunting, pigeon-shooting, coursing, battues, and rabbit-gins. Of late years I have added "vivisection" to the list. My husband's horses wear no bearing-reins; and I never see cruelty without interfering at the risk—as I know but too well—of personal insult. Finally, it is twelve years since I tasted flesh or fowl of any kind. Anna Kingsford

11, Chapel Street, Park Lane, W., March 16

[It seems a somewhat unwarranted and unworthy argument that because some foreign experimenters have been guilty of excess, therefore we are totally to suppress in England that which all competent persons know and declare to constitute a most im-

portant branch of physiological method; and there is certainly no ground for the statement that it is "the influence of public opinion only" which has hitherto prevented abuse in this country. As pointed out in our article, the English physiologists themselves took the initiative in laying down a code of rules against abuse some time before the sense of the general public was aroused, and it does not appear that since this has been aroused there has been any change in our physiological practices. Moreover, we cannot think that many of our readers will resemble our correspondent in failing to see that "atrocities" may be guarded against while "more moderate practices" are allowed; and in this connection it is always to be remembered that our English physiologists have gladly acquiesced in legislation directed against the former.—ED.]

TOWARDS the close of an interesting article on Vivisection in a recent number of NATURE (p. 429), the following remarks from an article in the *Fortnightly Review* by Lord Coleridge occur: "What would our Lord have said, what looks would He have bent upon a chamber filled with unoffending creatures which He loves, dying under torture deliberately and intentionally inflicted." Prof. Yeo in answering this, quotes "Ye are of more value than many sparrows," "How much then is a man better than a sheep." But there is one passage in Scripture which I think has even a closer connection with vivisection than those mentioned above, namely, the healing of the man possessed with devils (Mark v. verse 13), "and the unclean spirits went out and entered into the swine; and the herd ran violently down a steep place into the sea (they were about two thousand;) and were choked in the sea." If our Lord therefore considered it expedient to permit the destruction of a whole herd of swine, numbering 2000, in order to alleviate the sufferings of the demoniac, surely the labours of a man like Hunter must be justified, who by experiments on living animals has been the means of reducing death from aneurism of the principal artery of the lower limb from 95 per cent. to 10 per cent., as stated by Sir James Paget.

CHARLES ALEX. STEVENSON

45, Melville Street, Edinburgh, March 14

Muffs and Vivisection

YOUR correspondent, Mr. H. H. Johnston, of the Zoological Gardens, has offered your readers some "facts," which, he says, he "knows to be true." He says that some little time ago I called on "a distinguished member of science"; that "three things were observable in my outward presentments"—to wit, ostrich feathers in my bonnet, a bird of paradise on, *or near* my muff, and an ivory-handled umbrella; and that the man of science took each of these articles as a text for a rebuke to me for encouraging cruelty. Sir, these "facts" may possibly be "*accurate enough for scientific purposes*," like some others which we heard of at Bond Street, last winter, but they have given much merriment to those who happen to be acquainted with my real "outward presentments." Suffice it to say, that I never paid such a visit as Mr. Johnston describes; never received such a rebuke; never used an ivory-handled umbrella; never wore a bird of paradise, or any other bird, either in *or near* my muff, or any other portion of my attire; and, finally, having never possessed such an object in my whole life, am driven to think that the only Muff connected with the ridiculous story, must be the person who assures us he "knows" it to be true.

1, Victoria Street, S.W. FRANCES POWER COBBE

Pasteur's Inoculations

IN the *Proceedings* of the St. Louis Medical Society, recorded in the *St. Louis Medical and Surgical Journal* for December last, Dr. Spinzig is reported to have said:—"Splenic fever only prevails where there is low ground, or what is called 'bottom ground.' Sheep that are fed and shepherded on such ground will take this disease, while those that are shepherded in lofty regions never take it. But Prof. Pasteur had perfect confidence in his antidote, and asserted that if the sheep were properly 'vaccinated' it would make no difference where they were, because the specific poison could not reach them. In Germany, however, *they found this was not the case.*" May I ask, through your columns, what is Dr. Spinzig's authority for this statement?

Again, I have been informed, that although it has been abundantly proved that cattle and sheep inoculated with attenuated virus are protected against the otherwise deadly effects of uncultivated virus, they do not enjoy similar immunity from the ravages of a natural epidemic of splenic fever. I should be glad to know whether any record is forthcoming as evidence that the inoculation of the attenuated virus has proved as successful against natural epidemic arising under ordinary conditions as against artificial introduction of the virulent matter into the system.

A STUDENT

"Eophyton"

AFTER all that has been written, both in England and abroad, about the inorganic nature of Eophyton, it is strange to see such statements as those made by Mr. Elsden, in NATURE (vol. xxv. p. 409). As long ago as 1873, I pointed out that in Sweden it occurs under circumstances, which most decidedly prove that it *cannot* have been any plant or organic being whatever, and Principal Dawson has been led to precisely the same conclusions, from his studies of Eophyton at St. John. Last year, I further, by way of experiment, produced Eophytons, which cannot be distinguished from the Cambrian ones.

A. G. NATHORST

Geological Survey Office, Stockholm, Sweden, March 16

"Telescopic Definition in a Hazy Sky"

MR. ROYSTON-PIGOTT'S letter in NATURE, vol. xxv. p. 77, reminds me that during the Transit of Venus in 1874, the sky here for the greater part of the day, being covered with thick but varying clouds, I several times, for a considerable time together, saw the planet on the sun's disk, with the naked eye; the cloud at these times stopping out the superfluous light, but not stopping distinct vision.

I may add (though off the line) that, towards evening, the sun shone out brilliantly, and from my garden, through a bit of smoked glass, I watched the whole egress. Unfortunately, the subsidiary station, which was to have been here, had to be abandoned at the last moment, a matter of great regret to all concerned, and to all interested, and not the least to myself, having witnessed a great chance which there was no one to use.

Nelson, New Zealand, January 27 A. S. ATKINSON

The Weather in South Australia

MRS. MERRIFIELD, with her compliments, begs to inclose extracts from two letters she has recently received, describing the hot weather in South Australia during last January, also mentioning the curious fact, that the water in the Sturt river is more abundant in dry seasons than in wet ones. Perhaps the Editor may consider the statements sufficiently interesting for insertion in NATURE.

Stapleford, near Cambridge, March 14

"On Tuesday, January 17, the thermometer was registered at 180° in the sun, and 114° in the shade. I believe we had it hotter here; for, in the afternoon, the hills were covered with bush-fires. Fortunately, they were on the other side of the railroad, about two miles off. At night, when the fire was nearly out, and only the stumps and dead branches left burning, it looked like a large town lighted up. A strong south-east wind blew the heat over to us. In the morning, a strong hot blast came from the north, as hot as I have felt it in West Australia. Yesterday, the thermometer fell, out of doors, to 90°. To-day (January 19) was, I think, as hot in doors as on Tuesday. Metals in the room were unpleasantly hot to the back of the hand. The leaves are falling off the trees, from the intense heat and dryness of the air. The ants, which up to 9 a.m. were busy, forming a column varying in width from eighteen inches to three feet, and almost colouring the ground, retired to their nests. Not one was to be seen. Neither a bird, fly, nor other insect was visible, unless disturbed by the rustling of the leaves. The following statement will show the hottest days in certain years:—

In 1860	...	thermometer	158°
1862	...	,,	159
1871	...	,,	153
1880	...	,,	172
1882	...	,,	180

"*February* 2

"It is a curious circumstance that the Sturt river or creek, which runs through Mr. L.'s garden, has more water in it in dry

summers than in wet years. The present is a most unusually dry season, and there is much more water in the creek than there was last year. The Sturt is called 'a river,' but, like most Australian rivers, it is at times only a series of water holes; the water really running under the bed of the river. One can walk across the bed of the river, dryshod, except where the deep holes are. We cannot account for there being a greater body of water, that is, that the springs are stronger during drought than at other times. There are bad accounts from the northern areas. There is no water. The crops, about six inches high, yielding four bushels to the acre. Water is obliged to be carted by rail to some districts, and at the mines on the Peninsula, they are obliged to set the stills to work. In the far north, the new settlers are in fearful straits for want of water, even for drinking. The weather has been more tolerable lately; but hot in the sun, very cold wind in the evening, when a fire is agreeable."

Variable Cygni (Birmingham) 1881

UNDER the above heading, in the *Astr. Nachrichten*, No. 2421 (March 7), Dr. Schmidt, of Athens, gives the results of his observations of this star, which became invisible to him on November 24, and remained so up to his last search for it on December 22 It must have been from rather superior telescopic power—scarcely from a better *atmosphere*—that I was able not alone to see it on December 21, but to recognise its deep crimson colour when no more than 12 mag., and probably less. I used a power of 53 on a $4\frac{1}{2}$ inch object-glass.

Millbrook, Tuam, March 11 J. BIRMINGHAM

A Strange Phenomenon

THE letter under the above heading in NATURE, vol. xxv. p. 410, does not describe a phenomenon altogether unique. A good many years ago a clergyman, well known to me, was passing over a low hill in this parish; while doing so, he encountered a sharp shower of hail, and on approaching the highest point of the ground, he was astonished to find an electrical display similar to that described by Mr. Moir, an elevated walking-stick behaving like a pointed rod on the prime conductor of an electrical machine. I understood that when the clergyman left the summit of the rising ground, the phenomenon disappeared, and that on at once retracing his steps it was again visible. Mr. Moir does not state his position with regard to the contour of the ground, but I strongly suspect that he occupied a position similar to that described above, and that he witnessed a natural display of the common class experiment of presenting a pointed metallic rod to the charged conductor of an electric machine. B.

Fyvie, March 13

STENO[1]

IN the galaxy of genius that glowed in the still dark sky of the seventeenth century some spots shone forth more bright than others, and the keener vision and greater knowledge of later times has detected there stars of surpassing brilliancy. It was a period of great intellectual activity, and there was much independence of thought and freedom of research. In natural science this was quickly felt, and in Italy—elastic Italy!—that first rebounds to every movement, the results were soon made visible. It is not always in the heaving mass itself we first detect it; a foreign body resting on the surface sometimes more clearly indicates the motion. So in the country of Frascatoro, Scilla, Cardano, Cesalpino, Imperati, Aldrovandi, it was a Dane who first put geological Science into shape.

[1] *Phil. Trans.*, vol. ii. p. 225.
Fabroni.—"Vitæ Italorum," vol. iii. p. 7.
Manni.—"Vita del Litteratissimo Mgr. Stenone," Florentiæ, 1775.
Pilla.—"... dissertatione N. Stenonis, "de solido intra solidum naturaliter contento excerpta in quibus doctrinas geologicas quæ hodie sunt in honore fa... et reperire," Florentiæ, 1842.
A. G. S.—"Biographie Universelle," Paris, 1825.
Lyell.—"Principles of Geology," vol. i., 1830.
Ramsay.—"Passages in the History of Geology." Inaugural Lecture, Univ. Coll. Lond., 1848, p. 10.
Capellini.—"Di Nicola Stenone e dei suoi studii geologici in Italia," Inaugural Lecture, University of Bologna, 1869.
Huxley.—Discourse at York meeting, Brit. Assoc., 1881, revised by the Author (NATURE, vol. xxiv. p. 452).

But a very remarkable man was this Dane, Nicholas Steno, and a curious history his. Born at Copenhagen in 1638, the son of a goldsmith in the service of Christian IV., he was brought up in the strictest principles of the Lutheran faith. Instead of following the calling of his father, he was educated for the medical profession, studied under Thos. Bartholin, and attended the lectures of Borrichius and of Simon Paul. Hence the work that first brought him into notice was human and comparative anatomy. Soon after he had obtained the degree of doctor at Copenhagen, he went to Leyden, attracted by the fame of Francis Sylvius, Van Horn, and others. Here he made the acquaintance of Gerard Blasius, to whom without any distrust or reserve he showed his recent discoveries of the parotid gland, and associated ducts, one of which is named after him *Ductus Stenonianus*; but Blasius seems to have dealt unjustly by him in this matter, and to have put forward as his own the discoveries communicated to him by Steno. It was soon, however, apparent that Blasius did not know enough about it to avail himself of the information he had thus gained and unfairly tried to make use of. Steno worked on, tracing by observation and experiment the relations between the salivary and mucous secretions and the blood.

He next turned his attention to the organs of vision and of smell, and in his comparison of the human body with that of the lower animals he may be considered one of the founders of the science of comparative anatomy.

About the year 1657 he published the results of his experiments on the eye of a calf, but he assumed too hastily an exact correspondence between that and the eye of other animals, especially man. In his work on the heart, too, he did not himself arrive at satisfactory results, but he did much to set others on the right line of inquiry, and we do not know how much Lower and other later writers were indebted to the earlier investigations of Steno on this subject. It will be seen that his chief work was that on the glands and various secretions, but it also was incomplete, and it remained for Richard Hall (*Phil. Trans.* vi. p. 3) to make out the true relations of the submaxillary glands.

In 1664 he published some embryological researches in a letter "On the manner in which the chick is nourished in the egg," which, with a letter "On the anatomy of the ray," is appended to his essay entitled "Observationum Anatomicarum de Musculis et Glandulis Specimen" (Copenhagen, 1664, 4to). On embryology he seems to have adopted the views of Marcello Malpighi.

While engaged in these various studies at Amsterdam he heard of the death of his mother, and returned to Copenhagen. After a short stay there he went for a tour through Italy and France, and in 1664 arrived at Paris with a view of carrying on his anatomical researches, now especially devoting himself to the investigation of the brain. In Paris he became intimate with Thevenot, and here also he made the acquaintance of Bossuet. The eloquence and earnestness of that remarkable prelate had such an effect upon Steno, that in 1667 he went over to the Catholics, which perhaps helped somewhat to secure for him the warm reception accorded to him by the Grand-Duke Ferdinand II. and his brother Leopold. He explains the reasons which had induced him to take this step, in a letter published by Fabroni ("Lettere inedite di uomini illustri," vol. ii.). Steno, after leaving Paris and making a tour through the chief towns of Italy, settled at Florence in 1666, where he met Carlo Dati, Francesco Redi, Vincenzo Viviani, and Lorenzo Magalotti. They, in spite of the jealous opposition of Jean Alphonse Borelli, who had had a controversy with Steno respecting the action of the muscles, all agreed in doing him honour, and invited him to become a member of the Academia del Cimento. He was appointed Physician to the Grand-Duke Ferdinand II. de' Medici, and under his protection and patronage had great opportunities of pro-

secuting his anatomical studies, as are shown by his further observations on the heart, among which he gives the results of his experiments on the heart of a dog; by his memoirs on the muscles of eagles; on the intestinal movements in cats; and on the bile ducts, &c.

Three years after the publication of these treatises on special points, he brought out his "Elements of Myology," in which he treated the subject more from a mechanical than an anatomical point of view. In a letter to Thevenot, published with this work, he gives an account of the dissection of a shark which had been captured off Leghorn in 1666, and especially discusses the character and mode of growth of the teeth of that animal. This seems to have been a favourite line of inquiry about that time, for next year (1667) Agostino Scilla published his work, "La Vana Speculazione disanganata dal senso," in which, with a view of proving the organic origin of fossils, he figures and describes sharks' heads and teeth, in order to compare them with the glossopietre, or fossil sharks' teeth, so commonly found in the Tertiary beds of Italy.

It was about this time 1667-9 that Steno extended his researches into the field of geology, and began to write a dissertation in Italian for the Academia della Crusca, of which unfortunately only the introduction has been handed down to us. This bears the title "De Solido intra solidum Naturaliter Contento Dissertationis Prodromus." (Florence, 1669, in 4to.)

In this work he showed that he held views far in advance of his age, at any rate that no one else had clearly stated them, for we cannot but feel that in most cases of this sort we have got the wisdom of many and the wit of one. The independent researches of a number of different observers suggest the same explanation, but each is afraid to bring it forward on the evidence that he alone has gathered. A bold clear-headed generaliser steps forward and says, why not accept the conclusions that naturally follow from the hypothesis that each of you severally feel would best explain the various phenomena you have been investigating?

At any rate Steno did give a fair sketch of the Principles of Geology, and showed that he had considered it from the petrological, palæontological, and stratigraphical point of view. He pointed out the difference between rocks of mechanical origin, and those which were due to chemical agencies, and further clearly distinguished those that were to be referred to ordinary subaqueous sediment from those which were the products of eruption.

He found it necessary to mention by way of illustration what any one would admit as soon as their attention was called to it, that if we found a deposit containing sea salt and the remains of marine animals, planks of ships, &c., we should allow that the sea had once been there, whether the bed was exposed in consequence of the sea having retired or because the land had been raised.

A great quantity of timber and things washed down from the land suggest transport by torrents and rivers. Charcoal, cinders, and calcined objects we refer to the action of fire.

If the strata are of the same kind we infer the same causes. But if the character of the deposits which make up a set of beds in one and the same place varies, we refer this to changes in the surrounding conditions affecting the flow, or the source from which the material was derived from time to time.

He further shows that although the lowest beds deposited over any area must conform to the shape of the underlying rock, the tendency of all sediment must be to assume a horizontal position; and so, when we find them highly inclined, we must refer this to subsequent movement, excepting, of course, in the case of false bedding, which probably he would include under his aqueous causes of inclination of strata.

He observes that mountains, often with flat tops, are made up of both horizontal and inclined strata, as may be seen along their flanks, and from all his observations inferred that once the mountains were not, that they do not grow, that there is no constant direction in mountain chains, and he infers that mountain regions are raised and depressed, and subject to rending and fissuring. Discussing the origin of springs, he shows that he had a clear idea on the subject of Artesian wells, which had been previously treated by Ramazzini [De Miranda fontium mutinensium scaturigine, 1596.]

As he had clear notions of the structure of the crust of the earth and of the origin of the sedimentary rocks, we are not surprised to find that he entertained correct views respecting the nature of fossils. He pointed out that some shells were preserved just as they had been left by the sea or lake; others had undergone a slight change, the original shell being altered or replaced, while, in a third case, the shell had perished and left only the cast in the rock. We must remember what queer ideas he had to meet when we read of his explanations and arguments to prove what seems now so clear; for example, how he dwelt upon the occurrence in the rock of a large shell bored by lithodomous mollusks, and had to combat the view that they were concretions! Again a common idea with regard to the sharks' teeth of Malta was that they were the spontaneous productions of the soil, while popular superstition referred them all to the miracle by which St. Paul deprived all the snakes in the island of their venom. So Steno had to meet the argument derived from the great numbers that are there found. He pointed out first that each fish has an enormous number of teeth; next that the sea often carries and collects into one place bodies of the same kind, sorting them, as we know now, according to their size, specific gravity, and so on; and thirdly, that these sharks herd together, so that it was likely there should be a large number of their teeth in one place; and he adds that as there are teeth of different fish as well as shells in the same beds, it was clear that we had to do with an ordinary marine deposit.

He does not seem to have determined the bones of the large mammalia or to have studied their mode of occurrence very carefully, for though he recognised elephants, he did not see the difficulty that arose from the occurrence of a great number of other large animals, nor did he realise in what ancient deposits they were found, and so he thought it a sufficient explanation to say that the elephants had been brought over by Hannibal. He was hampered by the attempt to classify the events of geology under six periods, and had rather to wrest his facts to make them fit with his explanation of the Noachian deluge.

It is less interesting to dwell upon these difficulties than to follow him where he made the great advances of his age, and laid down the simple law of palæontology that when we find a body imbedded in the rocks, and it is similar in all important points to a recent organism, it is a fair inference that it also did belong to such an organism, or when he gave as the result of his investigations that the deposits of past ages and their included remains were produced in just the same way as similar accumulations are formed in modern times, and that the succession of beds with marine shells such as were seen in various parts of Tuscany clearly proved that there had been alternate periods of submergence and of elevation over large areas.

In discussing the possible causes of these earth movements, he touches the question of internal heat, and in inquiring into the causes of hot and cold springs, currents of air of different temperatures, emanation of gases, &c., he speculates upon the effects of the internal heat of the earth, and here and there throws out hints of larger questions working in his mind, as, for instance, modifications of the earth's crust, such that the centre of gravity should no longer so nearly coincide with the

centre of figure; and we cannot but regret that, owing to the sudden interruption which now fell upon his scientific life, that work of which we have but the introduction was never finished, and the many interesting facts as to the changes which had taken place in historic times in Southern Italy were never recorded, and the many curious disquisitions we were led to anticipate are lost for ever.

In 1668 Christian V. offered Steno the Chair of Anatomy at Copenhagen, which he accepted, and entered upon the duties of his office with the delivery of a remarkable inaugural address pointing out the direct benefits that have been derived from the study of anatomy, not only in the alleviation of suffering in others, but from the pleasure of the intellectual pursuit itself. But though his talent was universally recognised, jealousy and bigotry combined to make it uncomfortable for him in his native place, and so he returned to Tuscany, where the Grand-Duke Cosmo III. intrusted to him the education of his son Ferdinand. Steno now began to turn his attention to religious questions, and gave up natural science. He thought he must endeavour to bring about the conversion of his old co-religionists, and wrote several theological works which involved him in a controversy with the reformed clergy of Jena. Innocent XI. rewarded his zeal by appointing him, in 1677, Bishop of Titopolis (*in partibus*), and Apostolic Vicar of Northern Europe.

Steno fixed his residence in Hanover, when the Duke John Frederick of Brunswick had just embraced the Catholic faith; but on the death of this prince in 1679, the electorate fell under the domination of the Bishop of Osnabruck, who belonged to the reformed communion, and would not allow any proselytising to go on in his states. Steno therefore had to leave; and after spending some time at Munster and Hamburg, withdrew to Schwerin, where he died November 25, 1687. His body was, at the request of the Grand-Duke Cosmo III, carried back to Tuscany and laid in the Basilica of S. Lorenzo.

A simple slab of marble, put up by the Catholics whose cause he had espoused, marks the spot. The inscription gracefully records the pious prelate's end. As far as we know, no relative stood by[1]—no man of science pronounced a eulogy over Steno's grave.

The epitaph runs thus:—

NICOLAI STENONIS
EPISCOPI TITOPOLITANI
VIRI DEO PLENI
QUIDQUID MORTALE FUIT HIC SITUM EST
DANIA GENUIT HETERODOXUM
ETRURIA ORTHODOXUM
ROMA
V RTUTE PROBATUM SACRIS INFULIS INSIGNIVIT
SAXONIA INFERIOR
FORTEM EVANGELII ASSERTOREM AGNOVIT
DEMUM
DIUTURNIS PRO CHRISTO LABORIBUS AERUMNISQUE
CONFECTUM
SVERINUM DESIDERAVIT
ECCLESIA DEFLEVIT
FLORENTIA SIBI RESTITUI
SALTEM IN CINERIBUS VOLUIT
A.D. 1687

In this epitaph nothing is said of what Steno did for science, and when the President of the International Geological Congress led the congressists from Bologna to Florence last autumn to place a wreath upon the tomb of Steno, and called upon the distinguished Danish antiquary, Waldemar Schmidt, to say a few words to those assembled round the last resting-place of his illustrious compatriot, it was felt that it would be a fit and pleasing thing to put another slab beside the old one, in memory of that gathering round his grave, and telling of the full appreciation of his worth as a man of science by those who came two centuries after him.

THOS. MCKENNY HUGHES

[1] Jacques-Benique Winslow, an illustrious name in the annals of anatomy, was descended from a sister of Steno, but otherwise we hear no more of his relations.

WIND MEASUREMENTS

SINCE the time of Hooke the accurate measurement of the wind has formed an object of experimental research. That philosopher, if not actually the first to invent an anemometer, at any rate appears to have been the first to write upon the subject, which since then has occupied the attention and exercised the ingenuity of many scientific men. The main result of these efforts was well shown last week at the exhibition of anemometers organised by the Meteorological Society. The President, in an interesting historical address, stated that the number which had been invented was at least one hundred and fifty, and upwards of forty of these were collected, besides photographs and drawings of many others. The exhibition was by kind permission held in the library of the Institution of Civil Engineers, at whose weekly meeting two papers, on the design of structures to resist wind, and the resistance of viaducts to gusts of wind, were very opportunely read.

It is not by any means generally recognised that there are two distinct objects for which the measurement of the wind is necessary; these are: (1) the determination of the actual motion or transference of the air itself; (2) the investigation of the effect of the wind. The two societies above mentioned well represent these two objects of anemometry, and all the instruments are included in one or other of the two classes, which are said to measure respectively the velocity and pressure of the wind. These terms, though convenient, are slightly misleading, as it is really the impulse of the wind which is in both cases measured—in one by its effect in producing the continuous rotation of a vane or set of cups, in the other by its statical effect upon a pressure board or column of air or liquid.

From the nature of the wind it is evident that nothing less than a continuous graphic record could be of much service, and but little progress was made until the invention, about fifty years ago, of self-recording instruments of both classes. The late Dr. Robinson, F.R.S., contributed more than any one else to the establishment of the velocity anemometer which, by the addition of Mr. Beckley's self-recording apparatus, is undoubtedly a model of mechanical invention. Mr. Follet Osler, F.R.S., as the result of much persevering labour and skill, has given to the world a pressure instrument of great excellence, and of this and the former, both of which may be regarded as the best types of the two classes, it may fairly be said that much improvement, at any rate in mechanical construction, can hardly be expected.

As to the tabulation of results, this is conducted with the most scrupulous regularity. Since 1874 the Meteorological Office has published hourly numerical records, from its various stations, of the direction and other elements of the wind. Quarterly records containing engravings of the actual curves are also published. These latter have rather fallen into arrears, the first volume of the new series for 1876 having been only published in 1881; but it is satisfactory to hear that the work of completing them up to the year 1880 is progressing, and it is to be hoped that they will always be continued.

In the face of all this expenditure of time and skill the meteorologist and the engineer alike proclaim the unsatisfactory state of the science. The engineering aspect of the question, viz. the effect of the wind, has recently excited considerable attention in consequence of the Tay Bridge disaster in this country, and of similar accidents abroad. It is evident that with the increase in the size of engineering structures, particularly in exposed situa-

tions, the force of the wind may become as great as that impressed upon the structure by the action of gravity. The recent account, in this paper, of the proposed new Forth Bridge, was a good example of the provision made for wind pressure, not only on the completed structure, but also during its construction. Notwithstanding this, the report of the recent Commission on Wind Pressure substantiates the statements already alluded to. This distribution of wind pressure over any surface appears to be very little understood, though the matter is being carefully investigated by more than one experimenter, and some results have recently been published. It seems, however, hardly credible that the maximum pressure to which a structure may be exposed is almost as great a matter of uncertainty; yet such is the case. The papers on wind pressure, above referred to, in spite of the existence of so many anemometers, endeavour to ascertain from a variety of sources, such as previous accidents, and reports of the effect of wind in storms, what the probable maximum pressure has been, both, however, assuming values for purposes of calculation far less than are actually reported. In the same manner, the Commission decided upon a limiting value only a little more than 62 per cent. of a pressure recorded by an anemometer, and believed by them to have actually taken effect in this country.

The fact is, that the motion of the air is, beyond all expression, most complicated. Were it not for this, there would be no necessity for obtaining both the velocity and pressure of the wind, for there is, by a first principle of dynamics, a fixed relation between these two elements; and if one were known, the other could be, at any rate, approximately deduced. In reality, any attempt to treat the wind as having steady motion for more than a very small distance in space, is certain to involve serious error, and the complications which are introduced, from even slight disturbing causes, seem quite beyond the powers of investigation. The engineer is concerned both with prejudicial effect of the wind upon structures, and its useful effect upon wind-motors. In both these cases the conditions are such as to greatly interfere with the steady motion of the wind, and the effect due to locality must be estimated and allowed for. The meteorologist needs observations of the wind at all elevations, and as pointed out by Mr. Laughton in his address, particularly at higher ones, where, judging from the experience of aëronauts, the motion of the wind is nearly as complex as below. Until the motion of the wind is better understood, weather forecasts must be more or less unreliable, and what has been said with reference to the mechanical excellence of the present anemometers and the regular tabulation of results, must not lead to the idea that there is no room for improvement. On the contrary, there is yet much to be done in directions which can here be only briefly indicated.

First, there is great necessity for improvement in the lubrication of the instruments, especially of that portion recording direction, so that in viewing a weather chart of the *Times* it may be certain that in light winds the arrows *really* show the direction and not directly the opposite one. Such an error as this, perhaps from some distant station, causes whole columns of the bulky hourly records to be worse than useless.

Secondly, the reductions for the relative velocity of the wind and cups, if made at all, ought not to be made, as is at present the case, by a factor now well known as the result of much costly investigation, to be erroneous.

Lastly, the locality of anemometers should be more carefully selected, or at least taken more closely into account, in discussing the effect of wind in storms.

The importance of some reform in the matter of wind measurement is obvious, since it is only by continued observations, under improved conditions, that a more reliable and satisfactory knowledge can be obtained of the aërial ocean in which we live.

H. S. H. S.

THE ZOOLOGICAL SOCIETY AND "JUMBO"

At the General Meeting of the Fellows of the Zoological Society on Thursday last, Prof. Flower made the following remarks with reference to the subject of the elephant, "Jumbo":—

Before the Meeting separates I wish to make a few observations upon the subjects which have just been under discussion. It has been said that there should be power in the Bye-laws to call Special Meetings of the Fellows of the Society; and the subject is certainly deserving of the consideration of the Council. The probable explanation why there is no such power already, lies in the fact that there are regular Monthly General Meetings at which all Fellows are able to be present, to ask any questions or to make any observations they think fit upon the management of the affairs of the Society and, upon notice having been given, to propose any resolutions.

With reference to the action of the Council in the particular case under consideration, their legal powers to part with any of the animals under their care have now been fully affirmed by Mr. Justice Chitty's judgment, and the expediency of their being able to exercise these powers at their discretion in all ordinary cases does not seem to be doubted by any sensible person. It has, however, been asserted that there was something exceptional in the case of the elephant in question. I would ask when, and by what means, can the line be drawn between an ordinary and exceptional animal? Two elephants have been sold within my recollection (one in 1854, the other in 1873), and no one ever disputed the power or discretion of the Council in parting with either. Certainly neither of them was called "Jumbo," a name which has clearly done much to foster the present agitation. If our "Jumbo" had been called by some name as unpronounceable as that of the two Indian elephants now in the Society's possession we should have heard much less of his virtues.

To speak of this animal as is done by Sir George Bowyer in the *Times* of to-day, as in any way comparable to the *Codex Alexandrinus*, is only equalled in absurdity by the statement lately made in a letter to the same paper by another Fellow of the Society, that if a certain Chancery suit were successful the animal would remain as a "permanent" inhabitant of the Gardens. How immortality was to be conferred on "Jumbo" I do not know. Our animals are only temporary possessions. All experience tells us that even elephants die, and, moreover, that whatever may be the case in their native land (a subject on which strangely exaggerated notions prevail), in this country they are never long-lived animals. Whatever means were tried to preserve "Jumbo," whether lawsuits, chains, or stone walls, it is absolutely certain that a few years would have seen his end in one way or another.

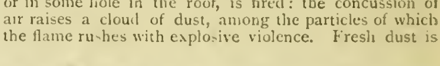
Then as to "Jumbo" being "unique," as is constantly said, I am not quite certain what is meant by this, as there are many African elephants at present in Europe, and one other in our own Gardens. As an elephant he is by no means perfect, wanting the most characteristic ornament of his race—the tusks. He is certainly large, but probably not larger than many other male elephants of his species would grow, if kept for a sufficient length of time. This very size, however, while in one sense adding to his value, is in another a serious detriment. It was, in fact, the principal cause of the desire to part with him. Then it is said that he was exceptional on account of his great money-value; but of what that value was no one could form any idea: in the general market it was literally nothing. I doubt whether, at all events a month ago, any one but the actual purchasers would have taken him off our hands at any price. I know, for my own part, so great has been my anxiety about him for several years past—so sure did I feel that he would one day or other bring us into trouble (although I can

scarcely say that I anticipated it in its present form), that I would willingly have consented to giving him away *gratis* if an opportunity had offered. Probably few of us admired the animal more than I did; but I have considerable knowledge of those who have attempted to keep such elephants in captivity in Europe. It is said that, as we have no difficulty in keeping lions, which are more dangerous, there need be no danger with elephants; but the deduction is not sound. A lion is always dangerous, and can be treated accordingly; an elephant, which inspires confidence by its usual docility, is on that very account a far more difficult and dangerous animal to deal with. In many zoological gardens on the Continent I have seen elephants boxed and chained up, without being allowed to take a foot of exercise, sometimes for years together; and on inquiry I have always found that it had been necessary to restrain the animal, because at some unexpected moment it had killed or injured its keeper. In India this would only be looked upon as an ordinary incident in an elephant's life; but if such an event were to happen in our Gardens (as I must say I have felt morally certain it would do sooner or later, if Jumbo remained there), what should we have had to do with the animal? Could we have ever again let him pace about the Gardens with his precious freight of little children on his back? But much worse than even killing a single keeper might have happened if the animal had once got beyond control. We have been warned by high legal authority of our responsibilities on this subject. It is possible that we may have been *too* apprehensive, *too* careful, about the lives of our servants and of our visitors; we may possibly have looked at difficulties incident to the management of our gardens, into the details of which it would be useless to detain this meeting by entering upon, in too serious a light; but this was a case in which we felt that to be on the safe side was the right course to pursue. I do not say that other bolder and more enterprising managers, who might look upon the attractions of the Gardens in a more commercial spirit, might not possibly have taken a different course; for we were quite aware that the loss of the animal might for a time be detrimental to the income of the Society. For this reason we also, as custodians of the Society's finances, thought it not right to decline to avail ourselves of the very unexpected opportunity of diminishing that loss, as far as possible, by the animal's sale. Some persons have called in question the "morality" of this transaction. How any one who has ever sold a horse, cow, sheep, or pig can do so, I cannot imagine. If the purchasers elect to take an animal, knowing all its imperfections, and the vendors are satisfied that it will pass into hands where there is every reasonable prospect of its being properly treated, what more can be required? Then we have been told that we ought to have killed the elephant. To this I decidedly demur, unless the principle is admitted that every one who has a horse, a dog, or any other animal, which has become through any circumstances inconvenient for him to keep, is bound to destroy it. This may be the doctrine of a few visionary enthusiasts, but it is not common sense, it is not humanity. If the life of an animal is of any use to it (and I see no reason why this elephant may not enjoy his life for perhaps a few years longer), there is no reason for taking it away until the time comes when it is absolutely necessary to do so. Besides, as I mentioned before, as trustees and managers of the Society's property, we are bound to look after its finances. You surely all know that the operations of the Society cannot be carried on without means, and that every penny received by the Society is spent upon the purposes indicated in the Charter; and yet many persons (I am almost ashamed to allude to such folly and ignorance), have spoken as if the Council, or the officers of the Society, had some direct pecuniary interest in selling the elephant. This brings me, in conclusion, to the one most serious side among the many ludicrous incidents that have arisen out of this affair. This is the rash or wilful misrepresentations that have been so freely indulged in against a body of gentlemen of whose general qualifications for the offices which they hold it is not perhaps necessary for me to speak in this assembly (their names should be a sufficient guarantee of this), but of whom I may say, from my intimate knowledge, that they are constantly endeavouring, often at considerable personal sacrifice, to bring their varied knowledge and experience to bear upon carrying out the work of the Society for the advancement of science, and for the benefit of the Fellows of the Society and the public generally. Our accomplished Secretary of whose successful general administration of the Society no one who did not know its condition as I happen to do before he took office, and has not watched its growing prosperity for the last five and twenty years, can form an adequate idea, has not been spared, although in his share in this transaction he certainly had no interest but that of the Society at heart.

There is much in this which is to me a novel and painful experience; but I am told that it is what all must expect who undertake the responsibility of any kind of work for the benefit of others. However this may be in political life, it might have been hoped that among those who followed the calmer pursuits encouraged by this Society, there would not have been any found who, either openly or under cover of anonymous slander in newspaper articles, letters, and postcards, would have imputed to us, which I regret to say has been so freely done, motives absolutely contrary to those by which we know we have been ever actuated.

ON DUST-EXPLOSIONS IN COLLIERIES

THE observations and experiments of M. Vital, in France, and of Mr. Galloway, Prof. Abel, and the late Prof. Freire Marieco, in this country, have shown, beyond all question, that we must look to the power possessed by coal-dust, and possibly even by finely-divided incombustible inorganic matter, when suspended in air, of propagating or enlarging the area of an explosion as one of the main causes of those frightful occurrences, which now and then decimate even an entire mining community. There can be little doubt, that so far as the loss of life is concerned, dust-explosions are, as a rule, far more disastrous than mere explosions of gas. A shot is blown out, or, by some mischance, the gas in the goaf, or in some hole in the roof, is fired: the concussion of air raises a cloud of dust, among the particles of which the flame rushes with explosive violence. Fresh dust is



raised, to form fresh fuel for the devouring flame, which, as in the case of the Penygraig explosion, so carefully investigated by Mr. Galloway, is thereby enabled to penetrate and search into the innermost recesses of the workings, provided they be sufficiently dry and dusty. Every particle of free oxygen is thus practically used up, and the resultant atmosphere is a suffocating mixture of nitrogen, carbonic acid, carbonic oxide, hydrocarbons, and partially-coked dust, against which the men, over whom the flame may have passed, with little hurt, have not the slightest chance.

It may possibly be of interest to those who, like myself, have to teach chemistry in a coal-mining district, to know of an experiment which illustrates in a striking manner the main features of a dust explosion. The experiment is to make an explosion at one end of a long and narrow wooden tube, representing the gallery of a mine; to show

that the concussion will raise a cloud of finely divided solid matter from the bottom of the tube along which the flame will be propagated and be driven out at the other end. *A* (see figure) is a wooden box 12 inches long, 8 broad, and 6 deep, closed on all sides, with the exception of a rectangular hole ($3\frac{1}{4} \times 2\frac{3}{4}$ inches), into which can be inserted a long narrow rectangular tube (B), also of wood, which may be 20 feet or more in length; the upper side (*cc*) of this tube is hinged, and along the bottom is strewed a thin layer of finely-divided dry coal-dust, or, what is better in the lecture-room, lycopodium powder. Into the wooden box, which in my apparatus has a cubic content of more than a gallon (5 litres) is placed about $1\frac{3}{4}$ pints (say 1 litre) of coal-gas; this can be most readily effected by pouring this amount of water into the box and displacing it over the water-trough by a current of the coal-gas. The opening is then closed by a sliding lid, and the gaseous contents are mixed by violently shaking the box for a minute or so. The end of the long tube (along which the powder or dust has been strewn, and the lid *c c* pushed down) is then inserted into the box, and the gaseous mixture is fired by thrusting a lighted taper through a small hole (*d*) at the end just where the tube enters the box. The mixture of coal-gas and air explodes, and the flame rushes along the whole length of the tube with astonishing velocity, and is driven, often to a distance of six or seven feet, out at the other end, and is followed by a cloud of smoke.

The experiment is unaccompanied by danger, and is so simple that it may be readily performed in a lecture-room. I showed it some time since to a number of colliers and others engaged in coal-mining, and it seemed to bring home to them far more forcibly than possibly any amount of mere description would have done, the real character of the phenomenon. T. E. THORPE

THE PHOTOGRAPHIC SPECTRUM OF THE GREAT NEBULA IN ORION[1]

LAST evening (March 7) I succeeded in obtaining a photograph of the spectrum of the great nebula in Orion, extending from a little below F to beyond M in the ultra-violet.

The same spectroscope and special arrangements, attached to the 18-inch Cassegrain telescope with metallic speculum belonging to the Royal Society, were employed which have been described in my paper on "The Photographic Spectra of Stars" (*Phil. Trans.*, 1880, p. 672).

The exposure was limited by the coming up of clouds to forty-five minutes. The opening of the slit was made wider than during my work on the stars.

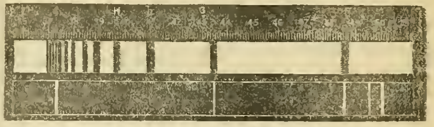
The photographic plate shows a spectrum of bright lines, and also a narrower continuous spectrum which I think must be due to stellar light. The bright stars forming the trapezium in the "fish's mouth" of the nebula were kept close to the side of the slit, so that the light from the adjacent brightest part of the nebula might enter the slit.

Outside this stronger continuous spectrum I suspect an exceedingly faint trace of a continuous spectrum. In the diagram which accompanies this paper the spectrum of bright lines only is shown, which is certainly due to the light of the nebula.

In my papers on the visible spectrum of the nebula in Orion, and other nebulæ (*Phil. Trans.*, 1864, p. 437, and 1868, p. 540; also *Proc.* Roy. Soc., 1865, p. 39, and 1872, p. 380), I found four bright lines. The brightest line, wave-length 5005, is coincident with the less refrangible component of the double line which is strongest in the spectrum of nitrogen. The second line has a wave-length of 4957 on Angström's scale. The other two lines are coincident with two lines of hydrogen, Hβ or F, and Hγ near G.

In the photograph, these lines which had been observed in the visible spectrum are faint, but can be satisfactorily recognised and measured. In addition to these known lines, the photograph shows a relatively strong line in the ultra-violet, which has a wave-length 3730, or nearly so. The wide slit does not permit of quite the same accuracy of determination of position as was possible in the case of the spectra of stars. For the same reason, I cannot be certain whether this new line is really single, or is double or multiple. In the diagram the line is represented broad, to indicate its relative great intensity.

This line appears to correspond to ζ of the typical spectrum of white stars (*Phil. Trans.*, 1880, p. 677). In these stars the line is less strong than the hydrogen line near G; but in the nebula, it is much more intense than



Hγ. In the nebula, the hydrogen lines F and Hγ are thin and defined, while in the white stars they are broad, and winged at the edges. The typical spectrum has been added, for the sake of comparison, to the diagram.

I cannot say positively, that the lines of hydrogen between Hγ and the line at 3730 are absent. If they exist in the spectrum of the nebula, they must be relatively very feeble. I suspect, indeed, some very faint lines at this part of the spectrum, and possibly beyond λ 3730, but I am not certain of their presence. I hope, by longer exposures and with more sensitive plates, to obtain information on this and other points. It is, perhaps, not too much to hope, that the further knowledge of the spectrum of the nebulæ afforded us by photography, may lead, by the help of terrestrial experiments, to more definite information as to the state of things existing in those bodies.

[1] Paper read at the Royal Society, March 16, by William Huggins, D.C.L., LL.D., F.R.S.

THE ACTION OF CARBONATE OF AMMONIA ON THE ROOTS OF CERTAIN PLANTS, AND ON CHLOROPHYLL BODIES[1]

1. *Roots.*

THE observations which led to the first of these papers were originally made many years ago on *Euphorbia peplus*, and have now been extended to other genera. A plant of *E. peplus* having been dug up and carefully washed, the smaller rootlets may be placed under the microscope without further preparation, the thicker roots may be examined by means of sections. If such roots are left, before being examined, in a solution of carbonate of ammonia (1 to 7 per 1000) for a short time (varying from a few minutes to several hours), they present a wonderfully changed appearance. The most striking alteration is that the surface of the root assumes a *longitudinally striped appearance*, due to longitudinal rows of darker brown cells, alternating with lighter coloured rows. The darker colour is seen under a high power to be due to the presence of innumerable rounded granules of a brown tint, which the lighter-coloured cells are without. Similar brown granules are deposited in cells scattered throughout the parenchyma, and markedly in the elongated endoderm cells surrounding the vascular bundle.

The granules are apparently neither resinous nor fatty, for they are not removed by alcohol or ether; they are,

[1] Abstract by Mr. Francis Darwin of two papers by Mr. Charles Darwin, read before the Linnean Society on March 16.

however, slowly acted on by caustic potash, and seem to be of the nature of protein.

It will be observed that the most remarkable part of the phenomenon is that the granules are only formed in some of the external cells, and that these cells are, before the treatment with ammonia, indistinguishable in shape or by their contents from their fellows, which are unaffected by the solution.

There is, however, a curious functional difference between the two classes of cells, namely, that the granular cells do not produce root-hairs, which arise exclusively from the cells of the light-coloured rows. With this fact may be compared an observation of Pfeffer's, that the root-hairs of the gemmæ of Marchantia grow only from certain definite cells. He describes a similar state of things in Hydrocharis, but with these exceptions it seems not to have been hitherto suspected that root-hairs arose from cells in any way specialised.

In connection with this fact, the theory suggests itself that the light-coloured cells have been emptied in consequence of the granules having been used up in the development of the root-hairs. But this view is not compatible with the fact that light-coloured cells may often be found which have not produced root-hairs. Again, in the case of Cyclamen, root-hairs are produced from granular cells. Effects similar to those now described were observed in some other Euphorbiacious plants, *e.g. Phyllanthus compressus*, though not in all the genera of this family which were observed. Among genera belonging to other families may be mentioned Drosophyllum and Cyclamen, as showing the phenomenon especially well. Altogether 49 genera were observed; of these 15 were conspicuously acted on, and 11 in a slight degree, making together 26 genera, while the roots of the remaining 23 genera were not acted on in any plain manner.

Before attempting to draw any conclusions, a few more details must be taken into account. The root must be alive, otherwise no precipitation will take place; the process is therefore a vital one, and seems in some measure to resemble "aggregation," as it occurs in the tentacles of Drosera. In both cases carbonate of ammonia is the most efficient re-agent, but other salts, such as nitrate of ammonia, produce a similar effect. What the nature of the process may be, must remain doubtful. The view here suggested is that the granular matter is of the natuae of an excretion; the arrangement of the dark-coloured cells in rows agrees with what we know of the disposition of certain cells whose function is admittedly to contain excretions. The granules are, moreover, deposited in the loose exfoliating cells of the root-cap where they cannot take part in the life of the root; and this fact points in the same direction.

2. *On the Action of Carbonate of Ammonia on Chlorophyll Bodies.*—The effects of solutions of carbonate of ammonia and of other fluids on the tentacles of Drosera, &c., was described in "Insectivorous Plants," under the name of "*aggregation*." This process consists essentially in the appearance of curiously-shaped masses, of an albuminoid nature, which undergo striking changes of form. The masses were believed to be protoplasmic, but this conclusion has not been generally accepted, and has been called in question by such authorities as Cohn and Pfeffer. The present paper is intended to show that carbonate of ammonia causes a kind of aggregation in chlorophyll bodies; and as these are undoubtedly protoplasmic, the belief in the protoplasmic nature of the aggregated masses in Drosera, and other carnivorous plants, is supported.

The changes which occur in the chlorophyll bodies may be well observed in the case of Dionæa. If a young leaf is immersed for twenty-four hours in a solution of carbonate of ammonia (7 to 1000), and is then examined by making thin sections, the contrast with a normal leaf will be found strikingly great. In most of the cells, not a single chlorophyll-grain can be seen, but in their place are found masses of translucent yellowish-green matter of diversified shapes, resembling in a general way the aggregated masses in the tentacles of Drosera. The matter is not exclusively derived from the chlorophyll-grains, but consists, in part, of matter deposited from the cell-sap, which is often the first to be formed, and is afterwards surrounded by the green matter derived from the chlorophyll-grains.

The same process may be observed in Drosera, and here it is not necessary to make sections, as the chlorophyll-grains may be well seen at the bases of the tentacles. Many observations were made in this way, and also by means of sections. In the case of Drosera it was possible to show that the chlorophyll-grains may recover from the effects of the carbonate—and this is a fact of some importance. After placing drops of various solutions on the discs of leaves still attached to their plants, green spheres or green zones surrounding a central purple mass were to be found in the tentacles. In this case it will be seen that the chlorophyll grains join with the purple cell-contents in forming aggregated masses. These masses were observed to be in constant slow movement. The leaves were then syringed with water and left to themselves for some days. When again examined, the green spheres had in large part disappeared, and instead of them normal chlorophyll-grains were found.

Other observations were made on Drosophyllum, Sarracenia, *Primula sinensis*, Dipsaeus, Pelargonium, Cyclamen, and many other genera, with various results. In some cases the chlorophyll-grains disappeared, and the green masses were formed, in other cases hardly any effect was produced; in others again the chlorophyll-grains became confluent and formed curious horse-shoe like masses in the bottoms of the cells.

In the case of Spirogyra the effects of the carbonate were well marked, the spiral chlorophyll body breaking up into variously formed rounded and pear-shaped masses, which slowly changed their outline. Here also plainly-marked deposition of fine granular matter from the cell-sap was caused by the ammonia solution.

Finally, it may be pointed out that whether or not the argument from the facts here given in favour of the protoplasmic nature of the aggregates in Drosera be considered valid, the observations themselves possess some independent interest.

NOTES

In the New Code it is satisfactory to find that science is placed on a fair footing. While in elementary schools, the substratum of instruction, in the form of "obligatory subjects," is reading, writing, and arithmetic, still the grants for optional subjects are such as to encourage teachers to make them a regular part of education. In the class-subjects for older scholars, for example, we find geography and elementary science, and these it is recommended, should be illustrated as far as possible, by maps, diagrams, specimens, and simple experiments. In geography the subjects for the different standards are carefully graduated; in Standard V., for example, such subjects as latitude and longitude, day and night, and the seasons, are set down; under Standard VI., among other subjects, are the "circumstances which determine climate;" and under Standard VII., "the ocean, currents, and tides, general arrangement of the planetary system, the phases of the moon." Under Elementary Science, again, the object of the instruction is stated to be the cultivation of "habits of exact observation, statement, and reasoning." For the first standards, lessons in "common objects, such as familiar animals, plants, and substances employed in ordinary life," are to be given. For Standard IV. there is required "a more advanced knowledge of special groups of common objects, such as (*a*) animals or plants, with particu-

lar reference to agriculture ; (*b*) substances employed in arts and manufactures ; (*c*) the simpler kinds of physical and mechanical appliances, *e.g.* the thermometer, barometer, lever, pulley, wheel and axle, spirit-level." For Standard V. we have "(*a*) animal and plant life ; (*b*) the chemical and physical principles involved in one of the chief industries of England ; (*c*) the physical and mechanical principles involved in the construction of the commoner instruments, and of the simpler forms of industrial machinery." For Standards VI. and VII. the preceding subjects are set down "in fuller detail." If two class subjects are taken, the second must be, in the lower division, either geography or elementary science ; in the upper division, history is added. Grants are also to be given for specific subjects, and in the schedule setting forth the subjects, the instruction is divided into three stages, and includes such subjects as animal physiology, botany, principles of agriculture, chemistry, physics (in two divisions—sound, light and heat, and magnetism and electricity). The syllabus under the various subjects has evidently been carefully considered, so as to give the pupil a fair knowledge of leading facts and principles. It is evident that the New Code, so far as science is concerned, is a great advance on the previous one ; science has at last something like fair play, and the next stage will doubtless be to include its elements among the obligatory subjects. There is now, at all events, a real stimulus given to teachers to encourage the pupils to take it up, and every precaution has evidently been taken to stamp out mere learning by rote, and to secure that what science is taught shall be real.

THE first report of the Royal Commissioners on Technical Education has been issued. It states that the Commissioners have conducted their inquiry into the instruction of the industrial classes under the following heads :—The instruction of the proprietors and superior managers engaged in industrial pursuits ; that of the foremen, and that of the workmen. During their recent visits to France and the north of Italy, they have collected data bearing on each of those heads, but they consider it is not desirable to publish the whole of the information thus obtained, until they have possession of the corresponding facts about other countries, including the United Kingdom. To publish the information at present without comment, would involve great risk of its not being properly understood, and the Commissioners are not yet themselves sufficiently informed to be able, in all cases, to present trustworthy conclusions. At the same time, they think it desirable to make known, without unnecessary delay, certain very recent changes in the French laws on public instruction, as well as the purport of others still under consideration. These changes are affecting, and will further affect, the ordinary and higher elementary instruction, both literary and technical, of the workmen and foremen in France. With the object of showing their influence upon the former class, an account is given of the present and recent position of various branches of instruction in that country. The report proceeds to give voluminous details respecting the systems pursued in French elementary schools and training colleges. Information is also given respecting adult art schools, shelter schools, State grants for technical instruction, and the outlay of French municipalities for local technical education. These points are dwelt upon as illustrating the activity in France in all that relates to the instruction of artisans. In concluding their report, the Commissioners state that they wish it to be distinctly understood that they have not made any recommendation for the improvement of the instruction of our own artisans beyond the introduction of manual work in some of the elementary schools. They have refrained at present from further recommendations, not because they are not fully alive to the need of greatly improving general and technical training in this country, but because they are at present only at the outset of their mission.

AT the half-yearly general meeting of the Scottish Meteorological Society held in Edinburgh on Wednesday, papers were read by Mr. Clement L. Wragge, on the observations made by him on Ben Nevis last summer ; by Mr. Buchan, on the results of the Ben Nevis observations, with more special reference to the Weather Forecasts; and by Dr. Arthur Mitchell, on the Smallpox Epidemic in London during 1881. A gold medal from the Council of the Society was presented to Mr. Wragge in recognition of his valuable services in connection with the Ben Nevis observations.

ON Wednesday evening, at 7 o'clock, Professors Abel and Roscoe, on behalf of the Chemical Society, the Society of Chemical Industry, and the Institute of Chemistry, received a large number of distinguished guests in the Crystal Palace, where refreshments were provided. Fifteen hundred invitations were issued and accepted, not merely within the limits of the United Kingdom, but in continental countries, and several eminent chemists from France and Germany came over expressly to join the gathering. The Crystal Palace was chosen as the meeting place because of the International Electrical Exhibition now being held there ; and the party dispersed themselves about the various exhibits. It was a gala night at the Palace, and the different electric lighting systems were shown at their best. The magnificent display by Edison in the Concert Room and Entertainment elicited much admiration ; so also did the fine candelabrum of 96 Maxim lights, executed in cut-glass by Messrs. Defries and Sons, and exhibited by the Electric Power and Generator Company. These lights are fed by a Maxim dynamo-electric machine capable of feeding 100 Maxim lamps of 30 candle-power each. The incandescent lamps of Mr. Lane-Fox, exhibited by the Anglo-American Brush Electric Company, the Bright system exhibited by the British Electric Light Company, and the Swan system were visited in turn, as also were the suite of apartments in the northern gallery lit by Edison's lamps. The visitors scattered about the various stalls, and a special train carried most of them away to town at 9.30 p.m.

MR. CLEMENT L. WRAGGE sends us the following communication :—The observations on Ben Nevis will probably be continued during the coming summer, and with this view I hope soon to revisit Lochaber, but it is yet too early to refer to definite arrangements. The museum I have placed in Stafford, the county town of my family, is lent to the town and county for twenty-one years, thereafter to become a gift if certain conditions have been complied with. The meteorological station there will probably be started next month. I regret to say that my negotiations for a central high level observatory on the Peak have fallen through. The owner of one portion of the land, annoyed by the operations of the Ordnance surveyors, has turned a deaf ear to my appeal, being determined to prevent any further trespass ; and the agent for another could only give me permission under conditions, one of which was that it would rest with me to compensate the tenants for disturbance of game. Moreover, the Meteorological Office could not see its way to provide an observer, on the ground of indirect telegraphic communication. The instruments were all in readiness ; and the barometer, a fine "Board of Trade," reading to 23·6, made to my order by Messrs. Adie and Wedderburn of this city in anticipation of no difficulty, is at present hanging practically idle. A series of high level meteorological stations in direct connection with Ben Nevis, would, I consider, be of the utmost value ; and until we get them we cannot hope to perfect our system of weather forecasting.

THE Congress relating to the protection of cables is not the only one which will be held in Paris next April. A circular has been sent to the different powers asking them to appoint scientific delegates to determine the exact length of the

mercury column, which is to be considered as equal to an ohm; secondly, to select a new standard for comparing the photometric power of several lights; thirdly, to establish a plan of common co-operation for studying atmospheric electricity as proposed by Sir William Thomson, and adopted unanimously by the Congress of Electricians.

THE French Minister of Public Works having sent a delegate to report on the Smoke Abatement Exhibition, it is supposed that M. Cochery will be obliged to reconsider his refusal to send delegates to the Electrical Exhibition at the Crystal Palace which extraordinary step has caused great disappointment in various quarters.

IN the *État de l'Algérie*, published by the new governor-general, we see that the Algerian system of meteorological observation extends from Mogador to Tripoli. The number of stations is forty-eight, but only thirty-six send daily reports by telegrams. The warnings of the Algerian meteorological office are telegraphed to twelve commercial seaports on the coast of Algeria. The most southern station is Wargla, in the desert where Laghouat, Tuggurt, and some others have been located. This office is directed by the staff of military engineers independently of Paris.

A FEW months ago the Rev. W. S. Green, of Carrigaline, Co. Cork, started on a mountaineering expedition to New Zealand. Mr. Green was accompanied by two Swiss guides, and a telegram just received announces that the party has succeeded in making the ascent of Mount Cook.

A BILL for compelling railway companies to use continuous brakes has passed the second reading in the House of Lords.

SIR JOHN LUBBOCK, as president of the Linnean Society, will give a *soirée* on Tuesday evening at the Society's Rooms, Burlington House.

THE Berlin Society of Commercial Geography, which has been in existence for about two years, has already developed a wonderful amount of activity. It publishes two organs, one weekly, under the title of *Export*, the other *Nachrichte fur Welthandel und Volkwirthschaft* at longer intervals. In both organs, while the development of German commerce is mainly kept in view, that object is sought to be promoted by obtaining at first hand a scientific knowledge of the products and peoples of the various countries of the world. The papers and notes on these points are all of great interest, and form important contributions to various aspects of geographical science. In this respect they form a marked contrast to the publications of similar societies in other countries, and we see one more evidence of the thoroughness of education in Germany, and of the utility of science in all departments of activity. This Society, there is little doubt, will be of great service to the development of German commerce; it seems to have competent correspondents in all parts of the world.

EARTHQUAKES are reported from the following localities:—On February 27, at 9.15 a.m., a number of weak shocks were noticed at Roveredo, lasting about six to seven seconds. They were also felt at Olivone, and far more violently at Bellinzona. On March 4, at 9.5 p.m., a violent shock, accompanied by subterranean noise, was felt at St. Johann in the Wieselburg Comitat (Hungary). The shock lasted two seconds, and proceeded in the direction from south to north. An undulatory and moderately violent earthquake occurred on March 11, at 2.54 a.m. at Metkovich, on the road to Mostar (the scene of the present revolutionary disturbances). Its direction was from north to south. The volcanic phenomena which have lately alarmed the inhabitants of the Ætolian coast have not yet ceased. There is now no doubt that a submarine crater has been formed. A short time ago a tolerably violent shock of earthquake was felt, accompanied by subterranean roaring and hissing. At the same time a strong odour of sulphuretted hydrogen rose from the sea. A thick layer of a gelatine-like mineral matter covers the surface of the sea to a great distance, and floats upon it like a layer of oil. It is not disturbed by the sea being in a high state of agitation, but has, on the contrary, a tranquillising effect upon the motion of the waves.

A TELEGRAM received at Constantinople, March 21, announces that three strong shocks of earthquake were felt on that day on the island of Chios. The population had taken refuge in tents, the temperature is excessively high.

FURTHER intelligence received from Panama states that during the recent earthquake in Costa Rica there was no loss of life whatever, and the damage to property was unimportant.

IT is related by MM. Macé de Lepinay and Nicati (*Jour. de Phys.*), that after a mountain excursion, and five hours among snow-fields, one of them found all artificial lights in town (candles and oil lamps) to appear distinctly green; the effect lasting from 7.30 to 11 p.m. This case of temporary daltonism for red is attributed to the fatigue of the retina for red persisting much longer than that for other colours. The authors describe a simple experiment by which this persistence may be verified. Three coloured glasses are taken, red, green, and blue, which, with average illumination, all bring the visual acuteness to about the same value. Having nearly shut the shutters and placed himself a few yards from a white board with printed letters of different sizes on it, the observer finds that, at the first, he can, with the blue glass, make out pretty distinctly the letters of medium size; whereas, with the red glass, the visual acuteness is so much reduced, that he cannot even distinguish the board. But if the darkness be continued, he observes that, whereas the visual acuteness does not sensibly increase with the blue glass, he is presently able, with the red, to make out, first the board, and then the largest letters. The visual acuteness in the latter case increases, at first quickly, then more slowly, for half an hour, when it becomes nearly stationary. Green glass gives results intermediate between the others. It is important to remark, that in all cases, even after an hour and a half, the visual acuteness with the red glass remains considerably less than with the blue.

A SMALL herbarium of plants, some thirty-five centuries old, must be an object of considerable interest. Such an one has recently been formed by Dr. Schweinfurth, from garlands found on the breasts of mummies discovered last year at Deir el Bahari, by MM. Brugsch and Maspero. Two garlands on the body of the King Aames I., consisted (according to a letter of the Doctor's published in *Archives des Sciences*) of leaves of Egyptian willow (*Salix safsaf*), folded twice, and sewed side by side along a branch of the date-palm, so forming clasps for separate flowers inserted in the folds. The flowers were those of *Acacia Nilotica*, of *Nymphæa cærulea*, with isolated petals, of *Alcea ficifolia*, and of a *Delphinium*, believed to be *orientale*. The garlands of the other kings contained flowers of *Carthamus tinctorius*, and the folded leaves were those of *Mimusops Kummel*. Leaves of the common water-melon (*Cucumis citrullus*) were also found on the body of Neb-Seni, a high priest of the twentieth dynasty. Dr. Schweinfurth managed to preserve many of the leaves and flowers, by moistening them, then putting in alcohol, then spreading out and drying. A remarkable thing is the preservation of colour of the chlorophyll violet in *Delphinium*, green in the water-melon leaves. All the species named are still found in the East; and they afford examples of both spontaneous and cultivated plants, continuing for many centuries without variation.

We have received part 4 of vol. ii. of "Appalachia," the organ of the "Appalachian Mountain Club." This Club is attempting to do in the United States what the Alpine Clubs are doing in Europe, and during the few years of its existence, has accomplished much in stimulating a love of science and mountain beauty in the community, also in making the mountains more accessible, and the more interesting parts better known. The part before us contains several interesting papers, mainly on the picturesque and historical aspects of the Appalachians, but includes a paper giving useful elementary instruction in geodesy. The Club includes many names well known in science in its list, and from the present and previous numbers of its journal, we judge that it is doing good work.

In some experiments with flashing signals by the electric light, conducted on the evening of the 8th, at Woolwich, the clouds were lit up at intervals as far as the zenith over Chislehurst Common, a distance of between five and six miles. The sky was everywhere overcast; but the clouds were not hanging low at the time.

At the Paris Academy of Sciences, on Monday, M. Blavier, mining engineer, called attention to the disappearance of the sardine from the coast of Brittany, where it used to bring in the fishermen 15,000,000 fr. a year He attributed this to a change in the direction of the Gulf Stream, which also accounted for the mild winter and early spring. On the suggestion of M. Faye, the question was referred to a committee composed of MM. Faye, Janssen, Daubrée, and Admiral Jurien.

The grand *soirée* given by Admiral Mouchez at the Observatory of Paris, on Monday, March 13, was very successful. Electricity formed a prominent feature of the entertainment. The illumination of the Salon du Nord by Faure accumulators lasted from 10 p.m. till 7 in the morning without the slightest interruption. Twenty-five Swan lamps were fed by a weight of 2500 kilograms in the accumulators. On the following day at 6 o'clock an experiment was made before Admiral Mouchez to show that about half of the electricity contained in the apparatus had not been used. The total force so accumulated is valued at 40 horse-power, which agrees with the determination given by Sir William Thomson and other experimenters.

The Vienna apiculturists will hold an International Exhibition of live bees, honey, wax, hives, and all other objects relating to bee-culture, on April 8-15 next. Most European as well as Trans-oceanic countries will be represented. This is the first exhibition of the kind in Vienna.

Near St. Etienne (France) a new geyser has been discovered. At a depth of 1500 metres a vein of hot water was tapped, and the result is an intermittent fountain which sends its water to a height of 26 metres. The geyser ejects carbonic acid as well as hot water.

At the monthly meeting of the Council of the Royal Historical Society, held March 17, Lord Aberdare in the chair, Mr. P. Edward Dove, of Lincoln's Inn, was unanimously elected Secretary to the Society.

The Emperor of Russia has allotted to the St. Petersburg Geographical Society a sum of 20,000 roubles as a subsidy towards the erection of a second Russian polar station in Nova Zembla. It is expected that Lieut. Andrieff will be appointed chief of this new station.

According to the *London and China Telegraph* a railway has been constructed in connection with the Kaiping collieries in North China, and permission to run a locomotive has been granted by the authorities. Six miles of line have already been laid down. The locomotive was constructed on the spot by native workmen, and is said to be very creditably done. This is the first railway ever constructed on Chinese soil for the Chinese themselves, and with the consent of the authorities. The abortive Shanghai-Woosung line was built by foreign engineers with foreign capital, against the wish of the Chinese Government.

The additions to the Zoological Society's Gardens during the past week include two Martinique Water-hens (*Porphyrio martinicus*), captured at sea, presented by Lieut. A. H. Oliver, R.N.; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Hill; a Blotched Genet (*Genetta tigrina*) from South Africa, deposited; two Ruffs (*Machetes pugnax*), two Redshanks (*Totanus calidris*), British, purchased; two Common Badgers (*Meles taxus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

The Approaching Transit of Venus.—In reply to a question in the House of Commons on Monday, the Secretary of the Treasury stated that in connection with the proposed observation of this phenomenon, 275*l*. had already been voted on a supplementary estimate for 1881-2, 14,680*l*. is provided in the Civil Service estimates for the coming financial year, and it is anticipated that about 1000*l*. will be required in the year 1883-4, for the reduction of the observations. A ship of war would convey a party to and from Madagascar. We believe it is proposed to occupy a station on the west coast of this island, the meteorological conditions being more favourable than on the eastern coast, though there is understood to be a disadvantage (any inconvenience from which the presence of a vessel of war may obviate), that the west coast is not directly under the control of the central government of the island.

It is known that the necessary arrangements are being made, with the assistance of a committee of the Royal Society, who have named Mr. E. J. Stone, the Radcliffe observer, to be directing astronomer. If success attends the British expeditions, much will be due to the energy and discrimination which Mr. Stone is exercising in that rather laborious position, as shown by his report to the International Committee on the Transit, held at Paris last October. We understand it is proposed to drill the intending observers, as far as can be done, in preparation for the special features to be noted, under the immediate direction of Mr. Stone, at the Radcliffe Observatory, Oxford.

The Topography of the Planet Mars.—Prof. Schiaparelli has published a second important memoir, entitled "Osservazioni Astronomiche e Fisiche sull' Asse di Rotazione e sulla Topografia del Pianeta Marte . . ." (*Reale Accademia dei Lincei*, anno cclxxviii. 1880-81), to which we shall refer more particularly in an early column. By combining his observations at the opposition 1879-80 with those made at the favourable opposition of 1877, he finds the position of the equator of Mars referred to the earth's equator as follows:—Ascending node (1880), in 48° 7'·8, inclination 36° 22'·9—figures differing little from those provisionally adopted by Mr. Marth.

Ceraski's Variable Star, U Cephei.—Mr. G. Knott, writing from Cuckfield on March 20, remarks that a conveniently observable series of minima of Ceraski's variable, U Cephei (DM. 81°, 25), has come round again. He obtained a good set of observations on March 18, from which the date of minimum (middle of phase) comes out March 18d. 12h. 21m. G.M.T., or about 21m. later than the time deduced from carrying on Schmidt's ephemeris (*Astron. Nach.* 2382), using his period, 2·4927703d. The magnitude of the star at minimum was 9·5, which, Mr. Knott observes, confirms an impression that had presented itself to him from an examination of the light-curve, that *at alternate minima the star touches a somewhat lower magnitude as a rule.* The difference is not great, about two or three tenths of a magnitude, but he believes it has a real existence: an interesting result, if it should be confirmed.

Prof. Pickering, in his "Photometric Measures of the Variable Stars β Persei and D.M. 81°, 25," has the remark: "The star D.M. 81°, 18 is either variable, or its light in grades is erroneously given by Glasenapp." Mr. Knott finds that the star is certainly variable to the extent of about six-tenths of a magnitude, but is not yet able to say anything as to its period. It is a decidedly ruddy-coloured star. Place for 1855·0, in R.A. 0h. 38m. 28s.,

Decl. + 81° 10′·5. The star is No. 113·4 of Fedorenko's Catalogue.

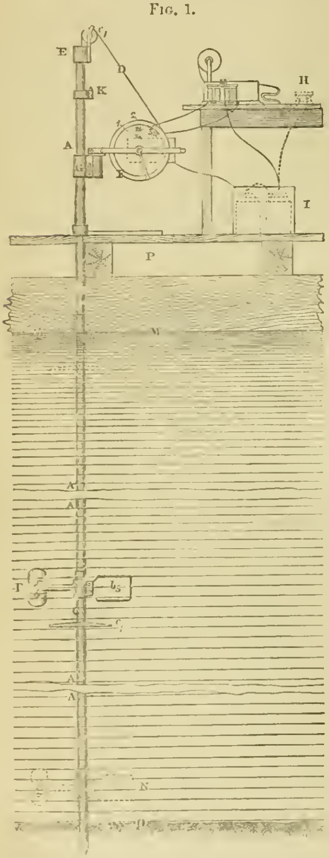
The following are times of minima of U Cephei to the end of April, inferred by Mr. Knott from his observations on March 18 :—

	h. m.			h. m.	
March 23	... 12 0	G.M.T.	April 12	... 10 37	G.M.T.
28	... 11 39	,,	17	... 10 16	,,
April 2	... 11 18	,,	22	... 9 55	,,
7	... 10 58	,,	27	... 9 34	,,

THE CURRENT METER OF PROF. A. R. HARLACHER[1]

PROF. HARLACHER, of the Technical High School at Prague, was the first to construct a current meter which obviates all the difficulties and drawbacks of the instruments

FIG. 1.

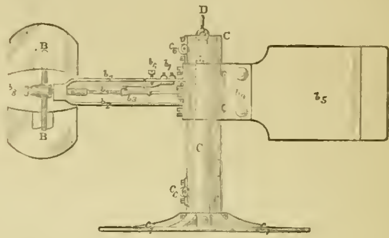


previously employed. The Harlacher current meter permits the velocity to be determined in the shortest possible time.

It is unnecessary to describe all the stages in the invention of the present form of the Harlacher meter. It is sufficient to say that Prof. Harlacher worked for several years at its improvement, and that his success was acknowledged by the award, at the Paris Exhibition, of two gold medals.

The Harlacher meter is constructed as follows:—For the movable staff, on which the Woltmann meter is fixed, an immovable staff or rod is substituted, which is planted firmly in the bed of the river, and along which the meter slides up and down during the observations on any one vertical. This rod is a cast-iron tube, with a solid point at the lower end, A, A (Fig.

FIG. 2.



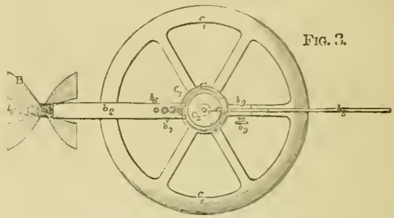
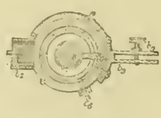


FIG. 3.

1). The other parts of the apparatus, except the electric battery and indicator, are fastened to the tube, so that the whole can be moved from one vertical to another, without having to be taken apart. The screw of the meter, B, is two-bladed. For very small velocities, it would be preferable to adopt a four-bladed screw of larger diameter. The screw is fixed on a steel shaft, b (Fig. 2), which has an eccentric enlargement at one point, b_3. This makes contact with the steel spring, b_4, at each revolution of the meter. These contacts complete the electric circuit, and the current which passes actuates the electric clock

FIG. 5.

FIG. 4.



or indicator. The weight of the screw B, the shaft b, and the brass box b_2, which carries the shaft, is balanced by a counterweight b_5 (Figs. 1, 2, and 3). This keeps the axis of the instrument in a perfectly horizontal position. The screw, b_6, serves to regulate the pressure of the spring, b_4, while the two screws, b_7, fasten the spring to the brass frame which surrounds and protects the shaft. The shaft is square at the end, which receives the screw, which is put on and held fast by a nut, b_8 (Figs. 2 and 3). The brass frame, b_2, is fixed to a hollow cylinder, C. Below the hollow cylinder, C, is a plate, C_1 (Figs. 2 and 3), which pre-

[1] By Richard Blum, City Engineer, Leipzig. From advanced copy of a paper in the *Proceedings* of the Institution of Civil Engineers, by permission of the Council.

vents the instrument approaching too closely to the bed of the river, where it might be injured or retarded by obstacles. In the interior of the cylinder, C, there is a cylindric case, c_2 (Figs. 3, 4, and 5), in which a brass spring is fastened, and through which the pin, c_3, is carried. To this pin the end of the suspending rope, D, is fastened. The internal diameter of the cylinder, C, is a little larger than the outside diameter of the hollow rod, A, on which it is to slide. The part, c_2, to which the rope is attached, is connected with C by an arm which passes through a vertical slit in the hollow rod, A. Thus, the instrument is kept always, if the pipe, A, is properly placed, with its axis normal to the plane of the cross section. The cylinder, C, is also fitted with rollers, c_6 c_6, which render the motion on the fixed rod easy. After the instrument has been placed on the rod or staff, a bracket, E (Fig. 1), with a pulley, e_1, is attached at the top, and the rope is carried over this pulley. The rope, D, is wound on a barrel, F. This barrel is fixed with the frame, f_1, and the pin, f_2, on the arm, G (Figs. 1, 6, and 7), which is firmly fastened to the hollow rod, A. With the barrel is connected the apparatus, f_3, registering the depth at which the meter is at any moment. The fan, f_4, and gearing, f_5, regulate the rate of rotation of the barrel and permit the adjustment of the speed of the meter in its descent along the rod, A. By the handle, f_6, the meter is again raised. The lever, f_7, and ratchet

FIG. 6.

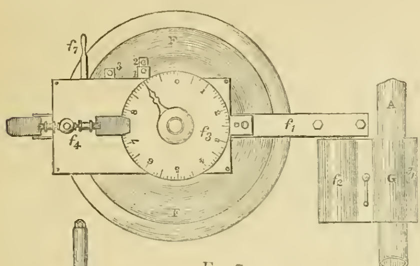
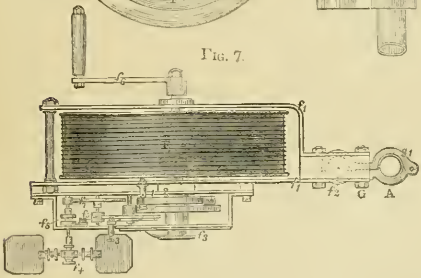


FIG. 7.



wheel, f_8 (Fig. 6), arrest the rotation of the barrel. The movement begins as soon as the ratchet is lifted by the lever. On the frame of the barrel, F, are fastened the contact screws, 1, 2, 3 (Figs. 1, 6 and 7), for attaching the wires of the electric circuit. The screw, 1, is connected with the rope, D, which is a copper-wire rope covered with insulating material. The rope is in electric contact with the shaft of the screw through the spring, c_3 (Fig. 5), because an insulated wire, c_7 (Figs. 5 and 3), connects the lower end of the pin, c_3, and the loop of one of the screws, b_7 (Figs. 2 and 3), which fasten the spring to the brass frame, b_2. The other conductor is the cast-iron pipe, A, which is in contact with the rest of the apparatus through the parts C, G, f_1, f_2 and F (Figs. 6 and 7). These parts are connected with the screw 2 (Figs. 1, 6, and 7). By putting a wire into the loop of screw 3 the depth of the meter below the water-line can be registered electrically. The registering apparatus, H (Fig. 1), has two dials, one marking single revolutions and the other hundreds of revolutions.

If desired, a recording arrangement can be added, the rotations of the meter being marked on a slip of paper in the same way as in a writing telegraph or chronograph. Prof. Harlacher used this arrangement in determining the variation of velocity at a given fixed point. The battery, I, and the clock, or indicator, H, with the rod, A, carrying the meter, are placed on a float, P. The sight vane, K, is fastened to the rod, A, so that it is parallel to the plane of the cross section, and then the axis of the screw is normal to the cross section and parallel to the current. The float is anchored in large rivers and fastened to guide ropes or poles in smaller streams. As soon as the work at one vertical of the cross section is finished, the anchor ropes on one side are slackened and on the other tightened, so as to bring the float into a new position in an easy and a speedy manner. The float must be built so as to be capable of supporting four or five persons.

The determination of the mean velocity at one vertical, by allowing the meter to slide once from the surface of the stream to the bottom, is accomplished thus. The meter, B, and all its connections, C, c_1, &c., are brought to within a few inches of the water surface, the fingers of the electric clock being set to zero. Then the barrel, F, is released by the lever, f_7, Fig. 6. As soon as the axis of the screw touches the water surface a signal is given, the electric clock is brought into the circuit by a spring lever, and begins to count the rotations of the screw. It is necessary to commence with the meter some small distance above the water surface, in order that it may acquire the proper descending velocity previous to the counting of the rotations. In a certain number of seconds the meter descends from M to N (Fig. 1), having at each point in its descent acquired the velocity of rotation corresponding to the velocity of the water at that depth. Dividing the number of revolutions by the number of seconds the rate of rotation corresponding to the mean velocity at that vertical is found. The fact that the disk, c_1 (Figs. 1, 2, and 3), prevents the meter from descending exactly to the bottom entails a small correction. This correction, however, will be more insignificant the larger the difference of the heights M N and N O, that is, the deeper the river in which the observations are made. It is a matter of course that the readings of the instrument at each vertical should be repeated, and the average of the results taken for the true mean velocity. The results of single measurements will not differ much from each other, but the repetition of the reading will give a certainty that all the variations of the velocity at the given vertical are allowed for.

Before using the meter, its constants must be determined in the same manner as with the Woltmann apparatus. A length is marked out in a still-water basin, and the meter is frequently moved through this distance at different speeds. It is essential that the movement of the boat or float on which the meter is fixed should be a uniform one.

The above description of the apparatus will prove that the advantages of this form of meter are of considerable importance.

THE STORAGE OF ENERGY [1]

THE subject of this lecture has been called by the world at large, even by well-informed *Punch*, "The Storage of Force." Why, then, have I ventured, in my title, to differ from so popular an authority? For this simple reason—that you cannot store force any more than you can store time. There is as much difference between force and work, as there is between a mile and the speed of a train or between a ship and a voyage. Work involves two distinct ideas combined, whereas force only involves one. When a weight rests on the ground, the weight pushes the ground down with a certain force, and the ground pushes the weight up with the same force. If, then, there were such a thing as a storage of force, the mere resting of a weight on the ground would be such a storage, since the force exerted between the weight and the ground never grows less. But, I need hardly say, it would be beyond the ability of the cleverest engineer to work a machine, or drive a train, by using a weight resting on the ground; the very expression, "dead weight," shows how useless it is for the practical purposes of producing motion. A weight resting on the safety-valve of a steam-engine may be a very good means of adjusting the pressure at which the valve shall open and liberate the excess steam, but this weight will never work the engine.

Work is force exerted through space; if a weight P be raised through F feet, P × F foot-pounds of work will be done, and there will be a store of P × F foot-pounds of work in the raised weight.

The continuous evaporation of the water from the seas and

[1] Abstract of a lecture delivered at the London Institution on Thursday, March 2, by Prof. W. E. Ayrton, F.R.S.

rivers by the heat of the sun, and its subsequent deposit in the form of rain on the hill-tops, supplies us with another very large raised weight store of energy, and which is practically utilised when the water falling down the hill-side works out water-wheels and turbines.

Various stores of energy arise from the separation of two bodies which desire to come together. The vast fields of coal form an enormous store of energy, owing to the tendency of carbon to combine with oxygen. Copper which is found pure and zinc, when separated from the oxygen with which it is combined in nature, are examples of the same kind. We may also have a store of energy arising from two bodies being too close together, and which desire to move apart; as, for example, in a coiled spring, in compressed gas, in two similar magnetic poles, or in two similarly electrified bodies near together.

The experiments now shown are examples of energy previously stored being utilised. This grindstone is being turned by a falling weight, the ventilating fan by falling water, this saw is worked by the gas-engine, the lathe by this galvanic battery, and the sewing machine by three Faure accumulators.

The water which is falling from the top of the building, and which is working this turbine, was really stored in the cistern for drinking and washing purposes, and, although serving us as a store of energy, it was not pumped up for this purpose. Indeed the price charged for water by the water companies would prohibit its use for the production of power. For, with water at a pressure of 100 feet, and at as low a price as *6d.* per 1000 gallons, it would cost *1s. 4d.* per horse-power per hour if the turbine had 80 per cent. efficiency.

In addition to the natural stores of water-energy on our hill-tops, there are also artificial stores of water-energy, or Armstrong's water accumulators, as they are called, although invented long before Sir William Armstrong's time, and which are employed in many large steel works, docks, &c. Water is periodically pumped into a cylinder with a heavily-weighted piston, which is therefore raised when the water is pumped in. If then at any moment, at any part of the works power is required, a tap is opened, and this large weight falling at the reservoir cylinder, drives out the water and performs the desired piece of work.

Now I want to consider how far it would be possible to drive a tramcar by one or other of these various sources of power. An ordinary tramcar for forty-six passengers weighs $2\frac{1}{2}$ tons, and when full of people about $4\frac{1}{2}$ tons. To pull such a car at the rate of six miles an hour along an ordinary line requires about $1\frac{1}{2}$ horse-power. To produce such an amount of power for one hour requires an expenditure of over 2,800,000 foot lbs of work, or if produced by a weight falling say through 10 feet, would require the weight to be over 100 tons.

Armstrong's water accumulators are therefore clearly useless for the purpose, and coiled springs are too cumbersome.

Steam-engines are occasionally employed on tram lines, and from the point of economy are much superior to horses; but there is the great disadvantage of the smoke, noise, and the terror of the horses of other vehicles. A detached tramway engine weighs as much as a full car, consequently nearly half the total horse-power employed is used in propelling the engine and boiler, and there is also the waste of power caused by the rapid radiation of heat from the boiler of a small engine. Gas-engines, though saving the weight of the boiler and coal, have the compensating disadvantage that per horse-power, the weight of a gas-engine is so much greater than that of a steam-engine, and cannot therefore at present be economically employed for tram-cars.

Compressed air engines have been employed with considerable success by Col. Beaumont for driving tramcars, and he has succeeded in storing in one cubic foot of air at 1000 lbs. pressure per square inch enough energy to pull three tons about half a mile along an ordinary tramway. But successful as this system is from the point of economy, there is the same objection that there is to the steam tram, viz. the comparative great weight of the locomotive. The detached compressed air engine weighs about 7 tons, while the car full of passengers is hardly 5 tons, so that seven-twelfths of the total horse-power expended is employed in pulling the compressed air engine alone. I understand it is proposed to build combined cars and compressed air engines, a change that will probably lead to a great improvement.

In order to obtain mechanical motion, we require a store of energy, and some machine for converting the energy stored into mechanical work. Now experiment shows that the weight of an electric motor is but a small fraction of the weight of a small steam-engine and boiler per horse-power developed. Electric motors, indeed, can be easily made to give out work at the rate of 1 horse-power per 50 lbs. dead weight of machine, and hence the great advantage of using them for movable machinery. [Experiment shown of drilling holes in thick wood with a hand electromotor and raising large boxes with a small electric hoist.] The most economical store of energy we can convert into mechanical energy by the agency of electricity is evidently the energy of coal, and this is the store we shall mainly employ in driving electric motors. That is to say, coal will be burnt to produce mechanical motion, the mechanical motion will work a magneto or dynamo electric machine to produce an electric current, the electric current will be conveyed along the wires, and at the other end, by means of an electro-motor, the electric current will be reconverted into mechanical work. [Experiment shown.]

Instead of converting the electric current energy into mechanical motion I can convert it into heat, and I shall then have, as you see, the ordinary electric light.

But if the engine breaks down, the electric motor at the other end must stop, or the electric light go out; the constant occurrence of which accident has just decided the authorities at the Manchester Railway Station to discontinue the use of the electric light. To prevent this effect following such an accident, an electric accumulator is needed, that is a reservoir which has been drinking in the electric energy when the engine was going at its best, and which will now give it out when the engine has stopped. Again, apart from accidental fluctuations in the speed of the engine, or total breakings down there is another most important use for the electric accumulators. That the electric lighting of towns will become general, I need hardly stop to prove to you, and that it will be carried out in ways quite different from the expedients temporarily adopted is also equally obvious. But users of electricity in this country have at present to manufacture their electricity as they require it, and are in the same position that gas-companies would be in if they were unable to store their gas, but had to manufacture it all while it was being consumed. They would evidently require much larger and consequently more expensive plant. Now the experience of two years has shown that, for large buildings, the electric light is far cheaper than gas. How much cheaper will it then become, when the electric energy can be manufactured at any time convenient, and stored until it is required to be used.

The earliest form of accumulator was simply a voltameter worked backwards. Now although Sir William Grove greatly increased the efficiency of this secondary battery by coating the plates with platinum black, still it was of little practical importance because of the rapid escape of the greater portion of the gases formed, if the charging was continued for a long time, as well as their diffusion through the liquid.

It is clear, then, we must arrange matters so that the passage of the primary current, forms on each plate a substance which has no tendency to wander over to the other. Such a substance must obviously be a solid, and a solid not soluble in the liquid. Now, an oxide of lead satisfies, in a marked degree, these conditions, and hence the employment in secondary batteries of this oxide, produced usually by sending an electric current between the lead plates immersed in dilute sulphuric acid.

But, in addition to having the plates near together, they must have large surface, in order to store much electric energy. And the way to give the plate a large surface, without making it inconveniently large, is to make it spongy. Hence what is aimed at is two spongy lead-plates near together.

Planté's method of accomplishing this occupied some months, and even when "well formed," his cell does not store very much electric energy, so that it has hardly ever been used for any commercial purpose.

In 1880, M. Faure thought of the device of putting a thick layer of red lead on his lead plates, a substance which can easily be reduced to spongy lead by the passage of a current. The plates, after being coated with red lead, are then wrapped in flannel jackets and put side by side in a box, every alternate plate being connected together, so as to practically produce two plates with very large surface very near together. To form the cells, reverse currents are sent somewhat in the same way that they are sent in forming the Planté cell, with the exception that only days and not months are required in the formation. The red lead on the one side is reduced to a spongy material, which is probably lead very slightly oxidised; on the other side, it is reduced to lead peroxide. Charging the cell, by sending a current in the direction of the last current sent, reduces the sub-

oxide to pure lead, and the lead peroxide, on the other side, to an even more oxidised salt. On using the cell to produce an external useful current, the pure spongy lead becomes again slightly more oxidised, and the peroxide slightly less oxidised. In fact, there is a small quantity of oxygen which travels backwards and forwards as the cell is charged and discharged.

Now, does such a cell store electricity? No! emphatically no! When charging it, just as much electricity passes out as passes in, and, when discharging it, just as much electricity passes in as passes out.

Imagine a stream of water was turning a water-wheel, and the water-wheel was employed to raise corn up into a granary, the arrangement might be called one for storing corn, but certainly not one for storing water. So a secondary battery does not store electricity, but electric energy.

The pith, then, of Faure's discovery is the mechanical placing of a salt of lead on the leaden plates the presence of which layer of lead salt enables spongy lead to be produced in a few days, instead of requiring many months, when the spongy lead is electrically formed out of the lead plates themselves by the long passage of electric currents.

The next point to consider is: (1) the storing capacity of such an accumulator; (2) its efficiency; (3) its durability. Now I am, I am glad to say, able to give you more than hearsay evidence on this point, since Prof. Perry and myself have been engaged on rather a long series of experiments on this subject. I may mention that we were both rather sceptical about the merits of the Faure accumulator before commencing this investigation, since we feared that the reports of its excellent action were almost too good to be true. Our doubts, however, gradually dispelled themselves as the investigation proceeded, and we now are able to add our tribute to its practical value.

Let us take a single example of the storing capacity. A certain cell, containing 81 lbs. of lead and red lead, was charged and then discharged, the discharge lasting eighteen hours—six hours on three successive days; and it was found that the total discharge represented an amount of electric energy exceeding 1,440,000 foot lbs. of work. This is equivalent to 1 horse-power for three-quarters of an hour, or 18,000 foot lbs. of work stored per lb. weight of lead and red lead. The large curve shows graphically the results of the discharge. Horizontal distances represent time in minutes, and vertical distances foot lbs. per minute of energy given out by the cell, and the area of the curve therefore the total work given out. On the second day we made it give out energy more rapidly than the first, and on the third more rapidly than on the second, this being done of course by diminishing the total resistance in circuit. During the last day we were discharging with a current of about 25 ampères. But in connection with the storing power, there is a very curious phenomenon to which I think not nearly sufficient attention has been directed, and that is the resuscitating power of a Faure's cell. When a cell has been apparently completely discharged, and is left for a few hours by itself, it appears to have obtained a new charge. For example after the eighteen hours discharge just referred to, although there apparently was no electric energy left in the cell at the end, it was found that after a few hours' insulation, the accumulator could give a current of over 50 ampères, and produce therefore bright flashes of fire. The phenomenon is wonderfully like the invigorating action of sleep. In one case, during our experiments of an extremely rapid and powerful discharge, we found that in subsequent discharges after rest, the cell gave out three times as much energy as it did in the first discharge. The neglect of considering this resuscitating power has doubtless misled many people who have possibly discharged a Faure's cell very rapidly, into under-estimating its storing capacity.

Secondly, as regards efficiency. The efficiency of an electric accumulator—that is, the ratio of the work put into it to the work given out—depends on the speed with which it is charged, and the speed with which it is discharged. If charged or discharged too quickly, a certain amount of energy will be wasted, heating the cell itself; since, whenever a current passes through a body, some heat is developed, and the greater the current, the greater the heat, the latter, indeed, increasing much more rapidly than the current. Now, it is possible, in a way I will not at the moment trouble you by explaining, to distinguish between the work given to the cell to produce chemical decomposition and the work wasted by too hurried charging. Similarly, in discharging, it is also possible to find out how much of the electric energy stored up in the cell is wasted in heating it by too hurried discharging. Allowing for such unnecessary waste, experiment shows that, for a million foot-pounds of stored energy discharged with a mean current of 17 ampères, the loss in charging and discharging combined need not exceed 18 per cent.; indeed, in some cases, for very slow discharges, we have found it not to exceed 10 per cent. I do not, of course, mean by this, as some people have mistakenly imagined from the published numbers of Prof. Perry and myself, that a current of only 17 ampères can be obtained by discharging a single cell; since, of course, far greater discharge-currents can be produced if the external resistance be low; indeed, I shall show you a constant discharge of about 70 ampères presently. In speaking of the number 17, I merely mean to say that was the average current when the experiments on the efficiency above referred to were made.

As to deterioration, two months constant charging and discharging of the two test-cells showed no signs of deterioration.

I have said that a cell containing 81 lbs. of lead and red lead stored 1,440,000 foot-pounds of work. Now, consider what that means. It represents all the energy required to be expended to pull a tramcar containing forty-six passengers over two miles, after allowing for considerable waste of power in the electrical arrangements. The electromotor and gearing need not weigh, as I told you, more than about 200 lbs., to produce about two horse-power. We have, therefore, this wonderful conclusion, that about 300 lbs. dead weight contains all the energy and all the machinery necessary for over two miles' run of a tramcar with forty-six passengers. Now, is this result actually obtained at present in the tramcar running at Leytonstone, and which is propelled by Faure's accumulators? No, and why? Partly because the electro-motor has not been made to suit the accumulators, nor the accumulators the electro-motor, nor is the gearing adapted to either.

The cells, as at present made, would not give off their energy quickly enough; hence a greater number are employed, but which, consequently, require to be charged much less frequently than would otherwise be necessary. Indeed, in a ton of the cells as at present constructed, there is about fifty miles' run of a tramcar containing forty-six passengers.

But, in spite of the temporary character of this arrangement, the total weight of the Faure cells, dynamo and gearing combined, used at Leytonstone, is only $1\frac{1}{2}$ tons, or one-third of the weight of a detached steam or compressed air-engine commonly used for tramcars.

Spacious as is the Lecture Theatre of the London Institution, it is unfortunately not large enough to admit a tramcar. I have therefore done the next best thing to prove to you that the Faure accumulators really contain a vast store of available energy. We have here a circular saw which is now cutting wood over an inch in thickness. As you see, the circular saw is driven by that Gramme electro-motor, and the electro motor itself is fed by the energy stored up in these accumulators, and which was put into them by a dynamo machine yesterday, on the other side of London.

When the Faure's accumulator was first invented, there were various suggestions of electricity being delivered at houses every morning like milk in cans, and the exaggeration of this idea no doubt did something to prejudice the cells in the eyes of the public. The reason why milk is delivered in cans and brought by carts is simply because the total quantity required is so extremely small. If milk were required to be consumed in large quantities like water is, we should have it sent through pipes, and not by cans. The main use of the accumulators will be as stationary reservoirs corresponding with cisterns for water or gasometers for gas. But in certain cases where the accumulators can be used to propel a cart, as in the case of tramcars, not the cart employed solely to carry the accumulators, then there is not the same objection to their being moved about, seeing that the total weight necessary is small compared with that necessary for a steam-engine or a compressed-air engine for tram lines to develop the same horse-power.

Again, just as ordinary electro-motors are not made to discharge a Faure's cell rapidly, so ordinary electric lamps are unsuited for this purpose; and, therefore, although there is enough energy, in a 100 lbs. dead weight of Faure accumulator, to give a light of 1500 candles for thirty minutes, an ordinary electric lamp cannot be illuminated at all by a single cell. Mr. Edison, however, has been turning his attention to this subject, and here is the result of his handiwork, which arrived last night from America, and which is, therefore, shown for the first time in England this evening. This incandescent lamp, as you see,

only requires four Faure accumulators to illuminate it, this one eight, and this other one twelve. But must the accumulators be even as large as those I am using on the table? The answer is, No; if you do not require them to give out the light for a very long time. Four much smaller boxes would give just as much light as you see at the present moment; but, of course, would not keep the light burning so long. It is, therefore, now possible to have a box of accumulators and an incandescent lamp, and the whole thing quite easily carried by one man.

Last year Prof. Perry drew attention, in his lecture at the Society of Arts on the "Future of Electrical Appliances," to the great waste of energy that is produced by the coal being carried to the steam-engine, instead of steam-engines being brought to the coal, and the power given out by the engines conveyed electrically to the place where it was commercially required. Why, said he, should not the coal be burnt at the pit's mouth, or in the pit, or even in that part of the mine where the seams were thickest, and the engines driven by burning it used to work large dynamo-machines on the spot, and the power transmitted electrically to any towns where it was required? Again, it has been often asked, why should not the wasted power in streams be utilised? At present it is more economical to use steam-engines in a town than to do work in the country by means of the streams, and convey the manufactured articles over the hills into the towns; and for that reason one sees the old water-wheels, in the neighbourhood of a place like Sheffield, being gradually deserted, and the men preferring to pay a higher rent for steam-driven grindstones in the town, to a smaller rent for water-driven grindstones in the suburbs. The question then arises would it be possible to convey economically the power from the coal-pits or from the streams into the towns by means of electricity; and this obviously turns on, how much power can be got out of one end of a wire compared with the amount that is put in at the other. I have, during this evening, been talking of the measurements of electric energy put into or taken out of an accumulator in foot-pounds, and you may have wondered how it was possible to measure electric energy in the engineer's unit of foot-pounds. In reality it is very simple. The maximum amount of work a waterfall can do, depends on two things, the current of water and the height of the fall. In the same way, the work a galvanic cell or accumulator can do, depends on two things, the current it is producing, and what is called its electromotive force, the latter being analogous with the difference of pressure or head of water. Again, when electric energy is being turned into mechanical work by means of an electro-motor, the energy which is being put into the motor can be measured by the product of the current sent through the motor, and the electromotive force maintained between the terminals of the motor. Now, here are two instruments, devised by Prof. Perry and myself, an Am-meter and a Volt-meter, the one for measuring a strong current, and the other a large electromotive force. With these we will now make simultaneous measurements when we allow this motor, which is driving the lathe, and which is itself driven by an electric current, to run at different speeds. First, we will start with the motor, which has one ohm resistance absolutely at rest, by putting a break on it, and ending by allowing it to run as fast as possible.

Experiment performed and the following results were obtained:—

Speed of motor.	Current in Ampères.	Electro-motive force between terminals of the motor in volts.	Electric power put into the motor in foot pounds per minute.	Power wasted by the current heating the wires of the motor in foot pounds per minute.
0	15	15	$15 \times 15 \times 44.25$ *i.e.* 9956.25	$15^2 \times 1 \times 44.25$ *i.e.* 9956.25
Slow	10	21	$10 \times 21 \times 44.25$ *i.e.* 9292.5	$10^2 \times 1 \times 44.25$ *i.e.* 4425
Fast	4	28	$4 \times 28 \times 44.25$ *i.e.* 4956	$4^2 \times 1 \times 44.25$ *i.e.* 708

We see in the last case, when the load was light and the speed of the motor very great, there was less than one-tenth of the waste of power arising from the current heating the wires when the speed was very slow. On the other hand, we observe that the electro-motive force between the terminals of the motor has been practically doubled.

This simple experiment really points to the solution of economic transmission of power by electricity, and to which Prof. Perry and myself have on numerous occasions directed attention. It is, to allow only a very small current to pass through the wires connecting the electro-motor with the generator, and to maintain a very great electro-motive force between them; since, in this way, the amount of power transmitted can be made as large as we like, and the waste from the heating of the wires from the passage of the current as small as we like.

Reasoning in this way, Sir W. Thomson showed, in his inaugural address last year to the British Association, that, if we desire to transmit 26,250 horse-power by a copper wire half an inch in diameter, from Niagara to New York, which is about 300 miles distance, and if we desire not to lose more than one-fifth of the whole amount of work—that is, to deliver up in New York 21,000 horse-power—the electromotive force between the two wires must be 80,000 volts. Now, what are we to do with this enormous electromotive force at the New York end of the wires? Fancy a servant dusting a wire having this enormous electromotive force. You might as well, as far as her peace of mind is concerned, ask her to put a lightning flash tidy.

The solution of this problem was also given by Sir W. Thomson on the same occasion, and it consists in using large numbers of accumulators. All that is necessary to do in order to subdivide this enormous electromotive into what may be called small commercial electromotive forces is to keep a Faure battery of 40,000 cells always charged direct from the main current, and apply a methodical system of removing sets of 50 and placing them on the town supply circuits, while other sets of 50 are being regularly introduced into the main circuit that is being charged. Of course this removal does not mean bodily removal of the cells, but merely disconnecting the wires. It is probable that this employment of secondary batteries will be of great importance since it overcomes the last difficulty in the economical electrical transmission of power over long distances.

I will conclude my lecture by illustrating one of the other important uses to which the accumulator can be applied, and that is the practical lighting of railway trains, which may be seen in daily operation in the Pullman cars on the Brighton line. The most natural method of lighting a railway train would be to attach a dynamo-machine to the axle of one of the carriages—the guard's van, for example—and the rotation of which, necessarily very rapid when the train is going fast, would, without the use of any gearing, produce the necessary current. But the difficulty that immediately meets us is that as soon as the train slows, or stops at a station, or in consequence of the signal being against it, the speed of the dynamo-machine will diminish and the lights will go out. If, however, while the train is going fast, the dynamo performs two operations, the one to keep the lights burning, the other to charge a battery of Faure's accumulators on the train, then the electric energy so stored can be applied to maintain the lights while the train is going slowly or stopping. With such an arrangement there would be, of course, an automatic contrivance for disconnecting the dynamo-machine from the circuit when the speed becomes too low; otherwise the Faure's accumulators would simply discharge themselves back through the dynamo-machine.

Imagine, now, we are in a train which is going slowly, or which has actually stopped, and that the Faure accumulators lying here on the floor is the Faure battery in the train, and which have been charged when the train was going fast; then that it has sufficient store of energy to continue lighting is proved, because, on connecting these two wires, those fifty Maxim lamps, kindly lent me by the Electric Light and Power Company, and eight Edison lamps before you, are instantly brilliantly illuminated, each of the former possessing about forty candle-power, and each of the latter about seventeen, and giving, therefore, far more light than is, at present, ever supplied to a whole train of twelve carriages. The light, you observe, is perfectly steady, and is turned on and off at will. Imagine, now, we are in a tunnel in the daytime, and the lights, therefore, burning. We now emerge from the tunnel into daylight. I disconnect the wires, and the lights are instantly extinguished. Again, it may be we are entering a second tunnel. The wires are again connected by the guard, and we have the whole of this lecture-theatre, which represents the train, brilliantly illuminated.

There has been an erroneous impression existing lately, that the Faure accumulator could not produce a constant current of more than 17 Ampères; but, that this is a mistake, is clearly seen from the fact that, at the present moment, each of the cells in this room is producing a current of about 75 Ampères.

Electric storage of energy, therefore, makes us nearly independent of accidents to the engine or dynamo machine, or irregularities in their working, enables us to receive our supply of electric energy from the central supply station in our proper turn, and independently of the particular time we require to utilise it, and lastly it enables large amounts of power to be transmitted over very long distances with but little waste.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The following notices have been issued with regard to lectures and classes in Natural Science for the summer term, beginning April 11:—

Prof. Clifton will give a course of demonstrations on instruments and methods of observation employed in optical measurements. The course is intended as an introduction to the study of practical physics in the Clarendon Laboratory. Mr. Stocker will deliver a course of lectures on Elementary Hydro-mechanics, and Mr. Heaton will form a class for the study of problems in Elementary Statics and Hydrostatics, these two courses being designed to meet the requirements of candidates for the Preliminary Honour examination in Natural Science.

Prof. Moseley, the new Linacre Professor of Physiology, proposes to commence a course of Comparative Anatomy, to extend over one year. The Professor's course is open to all students who have attended a course on Practical Biology, or Mr. Robertson's course on Histology. The Professor will attend after his lecture each day until 1 p.m. to superintend the practical work, which will be continued in the afternoon of that day and on the following day, by all students able to attend. Mr. Charles Robertson will give a course on the use of the Microscope and Histology to a junior class. The Professor will give an inaugural lecture on "The Zoological Results of the *Challenger* Expedition," in the large lecture-room at the University Museum, at 8.30 p.m. on Thursday, April 20. The lecture will be illustrated by means of photographs exhibited with the lime-light.

In the Department of Geology Prof. Prestwich proposes to have excursions to visit the several geological sections in the neighbourhood of Oxford on several Saturdays during the Term; and will lecture or give informal instruction on the subject of the excursion on each preceding Friday. Notice will be given from time to time in the *Gazette* and in the Museum of the places to be visited, hours of meeting, &c.

The Biological Fellowship at University College has been awarded, after examination, to Mr. J. T. Cunningham, B.A., late Brakenbury Natural Science Scholar at Balliol College.

Mr. Cunningham obtained a 1st Class in Mathematical Moderations, and a 1st Class in the Final Honour School of Natural Science.

The Delegates for licensing lodging-houses have appointed Mr. E. F. G. Griffith, C.E., to be Sanitary officer of the Delegacy for a period of two years.

Examinations for the Degree of Batchelor of Medicine, both First and Second, will be held in Trinity Term, on days to be hereafter notified.

Candidates for either of these examinations are requested to send their names, on or before May 1, to the Regius Professor of Medicine, Medical Department, Museum.

CAMBRIDGE.—Under the action of the new Statute A, which comes into force from the end of the present term, the entire Cambridge year is compulsorily lengthened a fortnight, and may be further lengthened at the pleasure of the Senate. Three terms are to be kept between October 1 and June 24 of the succeeding year, to include 227 days. Residence must be for not less than three-fourths of each term, instead of two-thirds as heretofore.

Section 12 of the Second Chapter of the Statute is important in the interests of science and reads thus:—"Students in science who, having already taken a degree in Arts, Law, Medicine, or Surgery, have given proofs of distinction in science by some original contribution to the advancement of science, and have done all that is required by the statutes and ordinances of the University, may be admitted to the title of Doctor Designate in Science, and shall afterwards be created doctors at the time prescribed by the University." In this Statute the claims of original work are fully recognised, and there is only necessary the formulation and promulgation of adequate regulations to place science in a sufficient position of honour in the University. It is provided in a subsequent chapter that honorary degrees in science may be conferred on foreigners or British subjects of conspicuous merit.

Section 19 of the same chapter is important, for it sanctions the adoption of affiliated colleges in any part of the British dominion, the recognition of their lectures and arrangements, and the allowing of periods of study at them not less than two years, as counting three terms towards a Cambridge degree.

The last report of the Board of Examinations (Ordinary Degrees) shows that in the year 1881 there were forty-eight candidates in chemistry, of whom nine attained a first class, and their papers were very favourably reported on, while fourteen failed; the examiner in geology (in which there were only three candidates) recommends that the examination should include one paper devoted to practical work, and that the subject should be divided into two branches, petrology and palæontology, of which one only need be taken. This seems an undesirable separation, seeing that the degree is given for geology only. In botany there were six candidates, of whom three passed in the first class, and three failed. Zoology attracted only two candidates. These results do not show that these latter subjects are neglected, but that a considerable proportion of the candidates who do not take honours, including many medical students, find chemistry the most advantageous subject for the B.A. degree.

The Examiners in Mechanism and Applied Sciences report favourably of the work done; there were five candidates in mechanism, two in electricity, and none in theory of structures. The papers were well done, and showed real interest in the subject, as well as a thorough appreciation of the principles.

SOCIETIES AND ACADEMIES

LONDON

Zoological Society, March 7.—Prof. W. H. Flower, F.R.S., president, in the chair.—The Secretary exhibited and made remarks on some living examples of *Helix hæmastoma* from Ceylon, which had been forwarded to the Society by Mr. J. Wood-Mason, F.Z.S.—Mr. W. A. Forbes read a paper on certain points in the anatomy of the Great Anteater (*Myrmecophaga jubata*), as observed in two adult female specimens that had lately died in the Society's Gardens. The arrangement of the ducts of the submaxillary glands and their relations to the stylo-hyoid muscle, the composition of the anterior cornu of the hyoid bone, the presence of clavicles, and the structure of the brain and of the female reproductive organs, were amongst the chief features touched upon.—Capt. G. E. Shelley read an account of the birds collected by Mr. Joseph Thomson while engaged on an exploration of the river Rovuma, East Africa. The collection contained examples of forty-three species of birds, among them being two new species, proposed to be called *Merops dresseri* and *Erythrocercus Thomsoni*.—A second paper by Capt. Shelley gave an account of a series of birds recently collected by Sir John Kirk, in Eastern Africa. This collection was made chiefly in the neighbourhood of Mambois, on the eastern slopes of the mountain-range which separates Ugogo from the Zanzibar province.

Anthropological Institute, March 7.—Major-General Pitt-Rivers, F.R.S., president, in the chair.—Mr. E. F. Newton, F.G.S., exhibited a Romano-British burial urn containing human bones that was found in Cheapside, about 18 feet below the footpath, in 1879. Two of the bones have green glass melted around them.—Mr. E. H. Man read the first part of a monograph on the Aboriginal inhabitants of the Andaman Islands. The paper contained an exhaustive description of the natives, based upon the lines laid down in the "Anthropological Notes and Queries of the British Association." Many points regarding the physical characteristics of these savages, on which misapprehensions have hitherto existed, were noticed. The latter portion of the paper was devoted to a description of the tribal communities and the peculiarities connected with the sub-division of the same among inland and coast-men; and reference was made to the system of rule and the power of the chiefs, and various details connected with their customs and mode of life were dealt

with. Their social and marital relations, superstitions, traditions, beliefs, &c., were reserved for discussion on another occasion. The author also exhibited an album containing a number of his photographs of the Andamanese, their huts, weapons, &c., and he further illustrated these subjects on a screen by means of a sciopticon and limelight.—Dr. J. G. Garson exhibited an Andamanese skeleton recently presented to the Royal College of Surgeons by Mr. W. Beatson, of the Bengal Medical Service.

Vienna

Imperial Academy of Sciences, March 2.—L. I. Fitzinger in the chair.—The following papers were read:—W. Biedermann, contribution to general nerve and muscle physiology (Part 8), on the apparent "Oeffnungszuckung" of injured muscles.—W. Becker, on the knowledge of the mouth-parts of the Diptera.—Fr. Woechler, on the material particles in the electric spark.—Josef Boehm, on the formation of sulphuretted hydrogen from sulphur and water.—M. Holl, on the correct explanation of the transvere processes of the lumbar vertebræ and the development of the spinal column of man.—E. Lecher, on radiation and absorption. L. Burgerstein, a geological study on the thermal springs of Deutsch-Altenburg.—A Koch, on the Meteoric fall of Moes in Transylvania.—E. Hann, on the Foehn at Bludenz.—V. Mises, on the nerves of the eyelids.

Paris

Academy of Sciences, March 13.—M. Blanchard in the chair.—The following papers were read:—Double decompositions of haloid salts of mercury, by M. Berthelot.—On the reproduction, by photography, of different phases of the flight of birds, by M. Marey. An instrument, like a rifle in shape, gives twelve successive images per second, each image taking 1-700th of a second. In bright sunlight, the time of exposure may be reduced 1-1500 sec. (a chronograph regulates the time). With Plateau's phenakistscope, the motion indicated by those images may be easily analysed. M. Janssen (whose "photographic revolver" for observing Venus' transit seems to have been suggestive to M. Marey) made some remarks.—On photography of the spectrum of the great nebula in Orion, by Dr. Huggins.—On an application of the theorem of Abel.—Considerations on the kinetic theory of gases, and on the vibratory state of matter, by M. Ledieu. This is meant to show that the present theory of gases presents a *secondary* kinetic hypothesis, which is quite gratuitous, and three errors of principle. Hence, a certain amount of experimental invalidation of it recently. But the *general* kinetic hypothesis remains intact.—Crystallised oxychloride of gallium, by M. Lecoq de Boisbaudran.—On a case of preservation against anthracic disease observed in man, by M. Cosson. A farmer had a slight anthracic affection, in 1854, and, in February last, another attack of very threatening character, from which, however, he quickly recovered. The earlier attack, M. Cosson conceives to have acted like vaccination.—New facts, proving the extreme frequency of transmission, by heredity, of morbid organic states, produced accidentally in ascendants, by M. Brown-Séquard. He has now, at the College of France, more than 150 animals showing this kind of heredity, all of them guinea-pigs (a species in which the nervous system seems to have a specially strong influence on nutrition and secretions). The new facts here given relate chiefly to alteration of nutrition of the eyeball; also to muscular atrophy through section of the sciatic nerve.—On uniform functions of an analytic point (x, y), by M. Appell.—Tempering by compression, by M. Clémandot. This new process consists in heating (say) steel to a cherry red, compressing strongly, and keeping it compressed till quite cool. The metal becomes very hard, and, like tempered steel, can be permanently magnetised. In either process of tempering *amorphism* is probably produced. There is advantage in the power of graduating the compression.—On the use of bitumen of Judæa in antiquity, as a preservative of the vine, by M. Leclerc. He quotes from an Arabian physician and naturalist of the tenth century, Temimi.—The death of M. Poitevin was announced and commented upon.—The Minister of Agriculture communicated a letter from M. Balbiani urging the importance of methodical experiments (of a nature indicated) both in the laboratory, and in cultivation on a large scale, with a view to destroying the winter egg of phylloxera.—On the theory of uniform functions of a variable, by M. Mittag-Leffler.—On uniform functions presenting lacunæ, by M. Goursot.—On the compressibility of gases, by M. Sarran. He gives some results with a method previously indicated.—Boiling temperature of zinc, by M. Violle. He obtains 930°, closely agreeing with M. Edm. Becquerel (932°). MM. Deville and Troost's figure was 1040°. The great difficulty of the determination lies in the small calorific capacity of the vapour.—Hydrodynamic experiments (fourth note); imitations with liquid currents, of Nobili's rings, obtained with electric currents, by M. Decharme. A thin liquid stream falls from a vertical glass tube, on a horizontal glass plate covered with a fine layer of minium suspended in water. Concentric rings, &c., are formed.—Apparatus for regulating the flow of a gas at any pressure, by M. Ville. This is placed between an *enceinte* and a reservoir of compressed gas, and, as the pressure in the former diminishes, admits a compensating quantity from the reservoir. Mercury, in a special manometer, closes a circuit, actuating an electromagnet, and thereby a valve.—On the heat of formation of ferrocyanhydric acid and of some ferrocyanides, by M. Joannis.—On the products of distillation of colophony, by M. Renard.—On chlorination of camphor; formation of bichlorinated camphor, by M. Cazeneuve.—On the essence of *Licari kanali*, by M. Morin.—On determination of tannin and œnogallic acid in wines, by M. Jean.—On gastric digestion, by M. Duclaux. *Inter alia*, raw albumen resists gastric juice much, and often leaves the stomach without suffering more than superficial action. Cooked albumen is more quickly attacked; then comes gluten, then blood-fibrin. The question why the stomach does not digest itself is not perplexing, when we know that gastric juice does not act indifferently on all albuminoid matter, but "respects" some.—Influence of the nervous system on the lymphatic vessels, by M. Bert. Stimulation of the mesenteric nerves caused constriction of chyliferous vessels; of the splanchnic, dilatation; but, with a curarised animal, there was dilatation in either case.—Chemical action of different metals on the frog's heart, by M. Richet. The toxicity of metals is not, apparently, related to atomic weight. These experiments give considerably different results from those with fishes. Some metallic chlorides stop the heart in systole, some in diastole.—On the passages by which the seminal liquid and the eggs are evacuated in the common Asteria, by M. Jourdain.—Geographical distribution of Coleoptera in Abyssinia, by M. Raffray.—Mode of formation of the coal-basin of the Loire; causes which modify, at various points, the nature of the coals, by M. Gruner.

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Erratum.—P. 463, column 1, line 17 from bottom, for "6¼ Ampères" read "6¼ Milli-Ampères."

THURSDAY, MARCH 30, 1882

ORIGINS OF ENGLISH HISTORY

Origins of English History. By Charles Elton. (London: Quaritch, 1882.)

MR ELTON'S work will at once take the place it deserves. It will be welcomed by the many students who have been long waiting for such a treatise on our country as it was during, the ages lying just outside the broad daylight of history. The subje t, with all the new resources of archæology and philology which have been brought to bear upon it, still presents a set of problems full of doubt and difficulty; but it will be seen that Mr. Elton's task has been not merely to bring these problems into shape, but to advance them by investigations of his own.

In the introductory chapter, which deals with the knowledge of the anci nts as to our part of the world, it is satisfactory to find the author bringing down to their real value the popular stories of Phœnicians in Britain. What is really recorded of the merchant-sailors of Carthage is their commerce with the tin-islands, but these Kassiterides, Œ trymnides, or Hesperides, are set down in Ptolemy's map as being off North-Western Spain, and it was Camden and other moderns who identified them with the Scilly Islands, so bringing the Phœnician galleys up into the British Channel. In 1874, at the Congress of Prehistoric Archæology at Stockholm, Dr. Hildebrand read a paper on the Kassiterides, which Mr. Elton does not seem to have met with, but which tallies closely with his own argument that the ancient accounts of their situation point to the Spanish coast. Dr. Hildebrand supposes the so-called islands to be only the headlands of Galicia, where tin is still mined, while Mr. Elton suggests that they were the little islands about Vigo Bay, an idea which would be strengthened by proof of old tin-workings being found there. Kenrick's argument that the tin-islanders going to sea in boats of leather were ancient Cornishmen paddling across to Scilly in "the characteristic boat of Britain" is fairly met by Mr. Elton, who points out that the Iberians had coracles as well as the Britons. Thus it is to be feared that Cornish history must give up the picturesque scenes of black-cloaked Kelts crossing to St. Michael's Mount at low water to barter their tin for the purple and fine linen of the Phœnician merchants, and to learn from them the art of scalding "Cornish cream." More substantial records of early Britain are to be had from a source long discredited but now restored to credit. This is the famous voyage of Pytheas to Thule, where he saw the midnight sun, and by describing this and other wonders of the north made himself the reputation of an arch liar, till now, two thousand years afterwards, his townsmen the merchants of Marseilles have set up a statue to him as the leader of the first Arctic expedition. In working out the details of Pytheas's expedition, our author follows him up the Spanish and French coast, by the British Channel into the German Ocean, up to Lapland (which he takes to be Thule), and down the east coast of England, back to Bordeaux. He makes Pytheas, after leaving Cadiz, come to the tin-islands, but it is not plain whether there is some actual record of this visit, or whether it is merely inferred that coasting up Spain above Cape St. Vincent must have brought him to the Kassiterides. The explorers passed the mouths of the Loire, and rounding Brittany, landed at Axantos (still Ushant), where they saw the temple and its nine priestesses keeping up the eternal fire. Not knowing how near he had come to the tin-districts of Cornwall, Pytheas sailed up Channel to the coast of Kent. Here he had reached the ordinary crossing place between Britain and Gaul, and here Mr. Elton places that much debated island which Timæus called Mictis, lying inwards six days' sail from Britain, in which the tin is found, and to which the Britons navigate in their coracles; while Posidonius describes it as an island lying off Britain, called Ictis, to which the miners of Cornwall carry their tin, taking it in carts across the intervening space which is left dry at ebb-tide, and there the merchants buy it and convey it across to Gaul, whence it is carried on pack-horses down to the Rhone. Mr. Elton's suggestion is that this Mictis, or Ictis, was the Isle of Thanet, six days' sail from the part of Britain where the tin comes from, and which, though now silted up almost close to the mainland, was even as late as the ninth century separated from it by a ferry half a mile wide. This is a very ingenious attempt to get over the difficulty in the ordinary theories, of putting St. Michael's Mount six days' sail from Britain, or of getting carts across to the Isle of Wight at low water. It has, however, its difficulties to meet, as the above extracts show, and Mr. Elton must be left to fight his own battle with the antiquaries.

Historians' ideas of the early inhabitants of Britain have changed curiously from those of a generation or two ago, when it was undisputed matter of fact that the Kelts were the aborigines of our islands, sprung from *Gomer*, son of Japhet, who colonised Gaul, and left his name to his descendants, the *Cymry*. Nowadays the Kelts have sunk into comparatively modern Aryan invaders, and the question is, How many peoples are to be traced before them? In the present state of the evidence, our author will hardly be found fault with for assuming three earlier races: first, the men of the Palæolithic or Mammoth period, who have not been proved to be connected with later inhabitants; second, the short, dark, narrow-skulled tribes who may be called Silurians, whose long-shaped burial-mounds contain stone weapons of Neolithic type, and whose descendants are to be recognised by their appearance, especially in South Wales and Ireland, though they now speak a Keltic tongue; third, a taller broad-skulled people seemingly of fair hair and complexion, and possibly allied to the modern Finns, who by their remains in the round barrows appear to have come hither armed with weapons of bronze, and encroached on and eventually mixed with their predecessors. After all these came in the invading Kelts, who were perhaps in the Bronze age when they landed on our shores, but who certainly possessed and worked iron long before the Roman Conquest. In Mr. Elton's good collection of passages relating to the Kelts, such terms as golden hair, milk-white necks, snowy arms, point to their being on the whole a fair race, which tells in favour of the idea just mentioned, that the dark complexion of so many modern Irishmen and Welshmen comes from an older Silurian ancestry. This ethnological speculation is doubtful

enough, but far more obscure is the question, who were this old dark-haired race of Silurians? The author, touching on the theory connecting them with Iberians or Basques, is quite alive to the slightness of the evidence pointing this way, and not less cautious as to the ancient words belonging to præ-Keltic tribes said to be preserved in Irish or Welsh.

Mr. Elton's department of original research lies especially in ancient legal customs, on which he has for years been the leading authority at the English Bar. Indeed the desire to get back to the historical meaning of customs which the law-books utterly fail to explain, is plainly the motive which has led him into the wider investigations embodied in this book. Naturally he is always on the look-out for legal relics of the earlier inhabitants, and for instance makes a striking remark on the succession of Pictish kings being not from father to son, but to the nearest male relative traced through the female line. This custom of kinship through the mother, which still marks many of the lower tribes of mankind, did not belong to the Kelts, who shared with other Aryans the rule of descent on the father's side, and it is fairly argued that the squalid tattooed Picts were of an older race, and kept up their ruder law of marriage. Again, the ancient custom still prevailing in many English districts, in the Vale of Taunton for instance, that the land goes not to the eldest but the youngest son, is here discussed more fully than it ever has been. The author's view is that whereas in the Aryan nations the eldest son's birthright was connected, as in India at this day, with the duty of keeping up the offerings to the divine ancestors, so the opposite custom of youngest-right may have come down from the religion of some ancient race in England, where, as among the Mongols still, the youngest son was the "fire-keeper" and inherited the home. In Germany, youngest right is frequent, and there it is on record that that quaint fetish or idol the mandrake root, dug up from under the gallows, half human in form and possessed by its familiar demon, used to descend at the house-father's death to the youngest son, on condition of his performing the pagan rite of burying bread and money in the grave. This is an interesting argument, though perhaps it may be answered that in new countries where the sons as they grow up go out and make homes of their own, the youngest son is the natural caretaker and heir of the parent's house and fields, and it is as likely that he performed the religious duties because living there made him the proper person, as that he became the heir because he had to perform the religious duties. How monuments and rites of older tribes find new and changed places in the religion of their conquerors, is here often brought into view. St. Boniface found the Frieslanders using as an altar a rude stone dolmen, probably a tomb built ages earlier by bronze-age inhabitants; the fierce Teutons would make a captive creep through the narrow opening of the upright stones, and then "sent him to Woden." After this, it does not seem surprising that our country folk should believe the rude stone dolmens on our hill-sides to have been altars for human sacrifice. Among earlier rites lasting on into Christianity, one of the most picturesque is that of Brighid the Keltic fire-god's daughter, who passed into St. Bridget, patron saint of Ireland and still name-giver to Biddy the typical Irish housemaid. But St. Bridget held to her old goddess-nature, and till the suppression of the monasteries her everlasting fire was kept up at Kildare by her nineteen nuns, who might not defile by blowing with their breath the flame sacred to the "woman of the mighty roarings"; each nun tended the fire one night in turn, but on the twentieth she who went off duty said "Brigit! take care of your own fire, for this night belongs to you." We are puzzled by Mr. Elton's remarks on the worship of Mithra, that ancient Aryan solar deity whose Oriental worship became so popular in Britain during the Roman occupation. The usually-known evidence seems to imply that the Mithra-worshippers fixed his divine birthday, the "Dies Natalis invicti Solis," on December 25, because the sun's birth would naturally be at the winter solstice, while it was not till long afterwards that this appropriate date was adopted for the Christian Dies Natalis, Christmas Day. Mr. Elton appears to take it the other way, as though the Mithra-worshippers for the sake of popularity borrowed the festival from the Christians. If he has some new evidence in this direction, it ought to be carefully gone into, and at any rate it will be well to clear the point up in the next edition.

What has now been said will give an idea of the more special researches in this important work. Readers of this journal will not disapprove of our having passed over weighty but ordinary historical topics, such as the invasions of Britain by Romans and Saxons, in order to give space for tracing lines of beliefs and customs. Some of these may seem trifling, but in the scientific study of history every trifle tells which can show a line of continuity from age to age and from race to race.

EDWARD B. TYLOR

WORKS ON THE MICROSCOPE

The Microscope and its Revelations. By William B. Carpenter, M.D., LL.D., C.B., F.R.S. Sixth Edition. Illustrated by 500 Wood Engravings and Twenty-six Plates. (London: J. and A. Churchill, 1881.)

Practical Microscopy. By George E. Davis, F.R.M.S., &c. Illustrated with 257 Woodcuts and a Coloured Frontispiece. (London: David Bogue, 1882.)

DR. CARPENTER is to be congratulated on the recent publication of the sixth edition of his very useful work on the Microscope and its Revelations, the more especially as now having the command of his own time, this edition is not only the expression throughout of his own matured views, but also contains a large amount of new matter.

A work like this which has proved itself so great a favourite needs but a brief notice at our hands. It is without doubt the book for the English reader to buy, who wishes to work as an amateur with the microscope; and should any such proceed further with the study, and penetrate into the mysteries of animal or plant life, he will find himself none the worse, but a great deal the better for the lessons he will have learnt in these pages.

The general plan of Dr. Carpenter's book is good; it begins with a short chapter on the Optical Principles of the Microscope. The question of there being a limit to the magnifying powers of the object-glasses, or whether there is a minimum behind which nothing can be seen, is not entered upon. The next two chapters—on the Construc-

tion of the Microscope and its Accessories—give a sketch of all the principal stands and apparatus in connection therewith; and is followed by two more, giving excellent directions for the management of the microscope, and for the preparation, mounting, and collecting of microscopical objects.

The second portion of the volume is devoted to an account of some of the more interesting forms of minute life to be met with, both in the animal and vegetable kingdoms. As this portion of the volume travels over a very wide field of research, so it is here that the greatest opportunities for criticism present themselves, but it is just to remark, that, despite the wonderful revolutions that have occurred in the domain of biology within the last few years, and despite the difficulty of keeping ever on a level with modern advances, a struggle only ending with one's life, Dr. Carpenter shows not only a wondrous energy, but a positive freshness in the adopting of new views. The notes on the green chromules of plant-cells are not quite up to the modern researches of Pringsheim, and we regret to find the author's sanction given to the use of the term *Gonidia* for the products of free cell-formation in the Cryptogams. The paragraph on the Nostocs might advantageously have been improved. No reason is given for uniting the Batrachospermeæ with the Florideæ. The chapter on protophyte and other fungi, seems very carefully written: the position of the myxomycetes is left doubtful, but Chlamydomyxa is brought into the same chapter. The new views on lichens are accepted, but the vacant space on the page which meets the view, might well have been occupied with a list of the algæ which play the part of hosts to the lichen fungi, which list would have proved, we think, that these forms do furnish objects of special interest, even to the ordinary microscopical worker, Dr. Carpenter's assertion notwithstanding.

It seems improbable that the antherozoids represented on page 396 as escaping from the Olpidium-like cell in the ultimate cell of the lateral branchlet of *Sphacelaria tribuloides* belong to the plant, and it is a pity that no illustration of a trichogyne is given in the account of the Florideæ, so as to call the reader's attention to what he may expect to see when looking for this special often rapidly-disappearing hair-cell. Nor is the open trichogyne in the easily procurable Coleochæta alluded to. Very scant justice is done to the Rhizocarps, and the true significance of the growth of the embryo in Lycopods appears to us to be overlooked.

Elfving's researches on the vegetative cells in the pollen-plants of the Angiosperms surely ought to have been referred to, as it opens a new and easy field of investigation to the microscopists.

The chapters devoted to those divisions of the animal kingdom which present objects of interest for microscopical research are well illustrated, and have been brought fairly up to the mark. The illustrations of Foraminifera are very good. The subject of Eozoon might perhaps have been better treated of in the chapter on geological investigation, and from the manual point of view is a little too controversial. We find no reference to the occurrence of calcareous algæ in a fossil state, and yet this is a subject which ought to command the attention of some of our microscopical workers.

Nothing that we have written must be taken as detracting from the extreme usefulness of this volume, which has for so long a period of time supplied an existing want.

Of a somewhat different type is Mr. George E. Davis's "Practical Microscopy." This author's object is to supply a book upon the lines of the late Prof. Quekett's "Practical Treatise on the Use of the Microscope," and his book treats of the forms of microscopic stand, of eye-pieces and objectives, of test objects, of section-cutting, and of the preparation and mounting of objects. In a chapter on the delineation of objects, a very detailed account is given of the subject of "photomicrography;" dry plates are preferred, and the various methods of using the camera are described, and the different modes of development are given. This volume will prove extremely useful to most practical workers, and the illustrations are both numerous and effective.

OUR BOOK SHELF

Elemente der Anatomie und Physiologie der Pflanzen. von Dr. Julius Wiesner. 276 pp.; 101 woodcuts. (Vienna: Hölder, 1881.)

THIS book is intended, as the preface tells us, to act as a syllabus or skeleton of Prof. Wiesner's lectures, thus sparing his students the labour of writing out full notes, and allowing them to give their intelligent attention to what is being said. The pretensions of the book are thus humble enough, and are, we think, well carried out.

The anatomy of plants is treated of in 153 pages, and into this space a great deal of matter is crowded. The style is simple and straightforward, and the author does not attempt to render his subject-matter easy by the slip-shod method sometimes called popular. From the nature of the book it must necessarily have somewhat the character of a catalogue; but the monotony which might be expected is not by any means a prominent fault. The numerous original drawings are from the hand of Dr. Wichmann, a pupil of Wiesner's, and are extremely well executed, though they lack the peculiar charm which we find in Sach's illustrations, and almost nowhere else. It is refreshing to meet with so large a proportion of original illustrations, instead of the usual reprints, and in this respect the book contrasts favourably with more ambitious works. How far the divisions into which the presentation of the anatomy falls will prove acceptable to professed anatomists, seems to us somewhat doubtful.

The physiological section of the book is, in some ways, probably, better than the first part, since it is the work of a physiologist in his own department. On the other hand, such a subject as physiology does not so well bear the somewhat abrupt treatment necessary in a work like the present. Again, Wiesner's standpoint in physiology is not attractive to many people, nor is it a very commonly accepted one. Few teachers, for instance, would wish their students to learn that negative heliotropism is due to the existence of negatively heliotropic elements. Yet this theory is the only one compatible with the somewhat obscure treatment of negative heliotropism here given.

Sounds and their Relations. By Alexander Melville Bell. (London: Trübner and Co, 1882)

MR. MELVILLE BELL'S name is a sufficient guarantee of the value of his work. His *Visible Speech* formed the starting-point of those recent investigations, both in England and on the Continent, which have thrown so much light upon the nature of sounds. In spite of the many new facts which have been observed and brought together since its first publication, its importance still remains

undiminished. It was, however, as its author says, mainly intended for the students of philology; and a simpler and more practical manual, therefore, was called for by the teachers of the deaf and dumb, the missionaries in foreign countries, the elocutionists and the trainers of common school teachers, who have all made more or less extensive use of it. Their demand has, accordingly, been supplied by a clear and compact manual, in which the character, varieties, and relations of phonetic utterances are explained by the help of the symbols of visible speech. The book begins with an explanation of the symbols themselves, and then goes on to analyse and distinguish the consonants and vowels, describing their physiological formation with a clearness of language and an appeal to the eye, which ought to enable the most backward of learners to reproduce the greater part of them after a little practice. The value of this section of the manual, to those who wish to acquire the pronunciation of a foreign dialect, need not be pointed out. It is only a pity that there are no means for enabling the ear of the ordinary speaker to detect the differences of sound, which, when once written down in "visible speech," he ought to find slight difficulty in reproducing. No method, however, has yet been discovered of training the ear, as Mr. Bell has succeeded in training the physiological organs of speech. What this success is, may be judged of from the last table given in the volume, in which such elementary sounds as sobs, coughs, yawns, sneers, or even a smoker's puff, are expressed by symbols that can be at once understood, and translated into audible sounds. The fourth section of the volume contains specimens of English, Lowland Scotch, French, and German, with their ordinary pronunciation exactly noted in Mr. Bell's symbolic alphabet, while the last section consists of a supplementary review of the essentials of articulation, with a couple of concluding pages on "the application of visible speech to the teaching of articulation to the deaf."

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Conservation of Solar Energy

WHILE Dr. Siemens' novel and ingenious theory described in his paper before the Royal Society, and published in NATURE, will doubtless be adequately criticised in its more physical aspects by those who are better acquainted than myself with "the intricacies of solar physics," I may perhaps be allowed to point out one or two conclusions which appear somewhat opposed to the laws of mechanics. The author, for example, lays great stress upon the "high rotative velocity of the sun," which at the solar equator, according to his figures, is four and a half times that at the terrestrial equator. To this "high rotative velocity" Dr. Siemens attributes the supposed expulsion from the solar equator of the products of combustion of the gases drawn in by the assumed fan-action at the solar poles.

Mairan apparently thought the equatorial rise of the solar atmosphere due to the centrifugal force engendered by this velocity sufficient to account for the appearance of the zodiacal light, and according to Dr. Siemens his supposition may possibly be correct, if we suppose that space, instead of being an æther-vacuum, is filled with highly-attenuated gases. It seems, however, that La Place, acting on the usual supposition of an empty stellar space, calculated that the solar atmosphere could not extend more than 9-20ths of the distance of Mercury, or about 16,000,000 miles, at which distance it would exist in such a highly rarefied condition as almost to merit the designation of vacuum. That this must be so, is evident when we remember that the high superficial velocity at the solar equator, though relatively larger than that at the terrestrial equator in the proportion given by Dr. Siemens, so far from being able to exert a powerful centrifugal force, is in this respect far less effective than the smaller tangential velocity at the terrestrial equator. This is chiefly due to the counteracting influence of solar gravity, which, as is well known, is more than twenty-seven times terrestrial gravity as represented by g. It is also partly due to the large value of the solar radius, since this also enters into the denominator of the expression for centrifugal force in terms of the tangential velocity, viz. $\frac{v^2}{r}$. It is at least remarkable that Dr. Siemens has made no allusion to either of these factors, which so intimately affect the centrifugal *efficiency* of the centrifugal force—the motive-power on which the entire action depends—and has made it appear from his language that this is a mere simple function of the tangential velocity at the solar equator.

As it is, owing to these united circumstances, but mainly to the former, the ratio of the centrifugal force acting on a particle to its weight is, even at the solar equator, almost infinitesimal.

To accentuate this astronomical platitude it is only necessary to quote figures which may be found in every popular work on the sun, such as the fact that while the centrifugal force at the terrestrial equator deprives a body of 1-289th of its weight at the poles, the amount it would similarly lose at the solar equator would be only 1-18,000th. Or again, to put it in another light, in order that solar gravity and centrifugal force may equilibrate, and a particle at the solar equator be without weight, the sun would have to turn upon its axis 133 times as fast as at present, while in order that the same conditions should prevail on the earth, its rotational velocity would only need to be increased seventeen times.

Except, therefore, where they would be momentarily affected by the local expulsive forces engendered by solar combustion, the different layers of the solar atmosphere would arrange themselves in the order of their relative densities, and remain quietly attached to the surface of the sun, under an attraction fully twenty-seven times greater than that which our earth exerts on its aërial envelope. That, under such circumstances, the centrifugal force of the sun could cause it to *project* into space the products of combustion, seems most improbable.

Moreover, suppose, for the sake of argument, that this action really does take place, can it be literally maintained, according to Dr. Siemens' concluding sentence, that this action is "capable of perpetuating solar radiation to the *remotest* future"? The laws of energy tell us that work cannot be done without expenditure of energy, and since the "primum mobile" in this case is solar rotation, and the gases entering at the solar poles must gradually acquire rotational momentum at the sun's expense, they must, in time, reduce it to nought, when the supposed regenerative action would cease, and so the sun burn out. In any case, therefore, the word "remotest" can only be understood to have a limited signification.

E. DOUGLAS ARCHIBALD

[To save time we submitted Mr. Archibald's letter to Dr. Siemens, who sends the following reply.—ED.]

This letter shows that Mr. Archibald has missed the principal point of my argument concerning solar fan-action. I showed pretty clearly I thought that solar gravitation would affect the inflowing and the outflowing currents equally, and that centrifugal action must determine motion in the equatorial direction in a space filled with matter. But to put the problem into a mathematical garb let us consider the condition of two equal masses m_p and m_a, both at the radius R from the solar centre, the one opposite either pole, and the other opposite the equatorial region. The moment of gravitation of both these masses will be represented respectively by $\frac{gm_p}{R^2}$ and $\frac{gm_a}{R^2}$, and supposing both masses to be gaseous, and of the same chemical composition and temperature, they will represent equal volumes, say one cube foot.

These conditions being granted, we may put—

$$\frac{gm_p}{R^2} = \frac{gm_a}{R^2},$$

but the mass m_a is subject to another force, that produced by tangential motion, which shall be represented by v, and the centrifugal force resulting from this motion by ϕv; the moment of gravitation towards the sun will then be reduced to $\frac{gm_a}{R^2} - m_a\phi v$, and the latter factor being a positive quantity we have—

$$\frac{g m_p}{R^2} > \frac{g m_a}{R^2} - m_a \phi v.$$

This inequality of attractive moments must determine motion toward the sun in favour of $\frac{g m_p}{R^2}$, and this condition holding good for any value of g and R, it follows that the polar inflow and equatorial outflow must take place, provided only that space is not empty, as supposed by La Place, but filled with either an elastic or non-elastic fluid.

To put it in another way, Mr. Archibald imagines that in order to determine an outflow from the sun it is necessary for the centrifugal moment $m_a \phi v$ to exceed the moment of gravitation $\frac{g m_a}{R^2}$, whereas according to my view, the value of the former determines only the rate of outflow, but is immaterial as regards the principle of action. The projection of dust is entirely dependent upon the outflowing current. I leave it for Mr. Archibald to determine for himself the velocity of current necessary to move a particle of dust of given size and weight away from the sun in opposition to its force of gravity, which I am well aware is twenty-seven times that of the earth on its surface.

The gaseous current is of course produced at the expense of solar rotation, but this expenditure of energy is relatively much smaller than that lost to our earth through tidal action, and may be neglected for our present purposes. It is moreover counterbalanced by solar shrinkage as explained in my paper.

C. WM. SIEMENS

Review of "Aristotle on the Parts of Animals"—A Correction

SINCE the publication of my review of "Aristotle on the Parts of Animals," a correspondent has called my attention to an article by Prof. Huxley, "On Certain Errors respecting the Structure of the Heart attributed to Aristotle" (see NATURE, November 6, 1879), in which the Professor corrects the common error, attributed to Aristotle, of describing the heart of the higher animals as possessing three cavities only. In ignorance of this fact I assigned the merit of originally detecting the error, so long attributed to Aristotle, to Dr. Ogle, who tenders, I have no doubt quite independently, the same defence of the matter. I now write to give the priority of the detection of the error to Prof. Huxley, and to thank my correspondent for having afforded me an opportunity of studying a most original and instructive essay.

BENJAMIN WARD RICHARDSON

25, Manchester Square, March 27

Deep-Sea Exploration in the Mediterranean

I SHALL be obliged if you will kindly announce in NATURE that, taking into consideration the vote expressed at one of the plenary meetings by the Third International Geographical Congress at Venice, the Italian Government has decided that the deep-sea exploration in the Mediterranean be continued during the forthcoming summer; and towards the end of July or beginning of August next I am to embark on board the surveying steamer *Washington*, Royal Italian Navy. About one month will be devoted to deep-sea exploration under the able direction of Capt. G. B. Magnaghi, R.N.

The study of the animals collected during last year's cruise will be completed with that of those we hope to collect next summer. Since presenting my Preliminary Report to the Geographical Congress, I have looked more carefully into the fishes collected last year; amongst them are two specimens of the rare *Malacocephalus lævis*, Lowe, dredged in 508 metres off the south coast of Sardinia, and in 823 metres off Mauritius (Egadi, Sicily); and two specimens of the still rarer *Coryphænoides serratus*, Lowe, new to the Mediterranean fauna, dredged from depths of 2805 and 2904 metres off the west coast of Sardinia.

Dr. J. Gwyn Jeffreys was here a short time ago, and has examined the mollusca, on which he will report.

HENRY HILLYER GIGLIOLI

R. Istituto di Studi Superiori in Firenze, March 23

The Basque Whale in the Mediterranean

I WAS very much interested in Mr. Clement R. Markham's most important communication on the "Whale Fishery" in the Basque provinces of Spain, produced in NATURE (vol. xxv. p. 365). Mr. Markham has carefully collected imporant materials for the history of a whale (*Balæna biscayensis*), which, if not quite extinct, appears to have become so, to all intents and purposes, in a region where it was once so common as to have given rise to an important industry, and to have had a powerful influence on the habits of the Basque people along the northern coast of Spain. Mr. Markham gives solitary instances of the appearance of the whale off the Basque coasts, up to a very recent period, and says that the last instance of its occurrence which came to his knowledge, was on February 11, 1878, when a whale was sighted off Guetaria, and successfully harpooned. This bit of news must have interested all cetologists, and I hope that it may interest Mr. Markham and the readers of NATURE to know that a fine, nearly adult female of *Balæna biscayensis* was captured just one year before, in the Mediterranean, viz. on February 9, 1877, at Taranto. It was ably and fully described by Prof. F. Gasco (*Mem. R. Acad. Scienze di Napoli*, vii. 1878); the entire skeleton is in the Museum of Comparative Anatomy in the University, Naples, in the Central Collection of the Italian Vertebrata at Florence. I preserve a portion of the skin of the snout, with short hairs, and a model of the entire creature, reduced to one-twelfth, carefully executed from drawings and measurements taken from the whale immediately after death. I know of no other recorded instance of the capture of a true whale in the Mediterranean.

HENRY HILLYER GIGLIOLI

R. Istituto di Studi Superiori in Firenze

Wind Measurements

AFTER reading the interesting article in NATURE, vol. xxv. p. 486, on wind measurements, the reader cannot but revert to the very unsatisfactory state of anemometry as it now exists. This is only too apparent from the reports which appear in the papers after a gale, and in which are generally detailed the estimated pressures and velocities of the wind as recorded by the anemometers at the principal meteorological stations. Thus during the gale of the 13th-14th of October last we were told that a pressure of 53 lbs. per square foot was recorded at Greenwich, and at the Bidston Observatory, Birkenhead, the pressure reached the alarming figure of 79 lbs. Now it may be readily shown without much calculation, that such pressures as these few buildings could withstand that were not of more than ordinary stability, not to mention the destruction of tall factory chimneys, which, when of the usual dimensions, will not stand a pressure of 30 lbs. per square foot. Yet no such destruction took place. I think, then, we must confess with T. Hawksley, F.R.S. (vide paper read before Section of British Association meeting, York, 1881, on Pressure of Wind on a Fixed Plane Surface), that our present anemometrical instruments are little better than philosophical toys.

C. H. ROMANES

Worthing, March 27

IN the account of D'Ons en Bray's anemometer, which I printed to accompany a drawing of that instrument at the Meteorological Society's Exhibition the other day, I stated that it was probably the earliest registering anemometer. I now find that I am mistaken, but as I erred in company with the President of the Society, I feel that I may well be excused. Until a still earlier instrument turns up, the idea of a registering anemometer must be ascribed to Sir Christopher Wren. In 1663 (see Birch's "History," i. 341, plate iii.), he laid before the Royal Society an account of his "weather clock," which is in fact a recording anemometer, but for direction *only*, together with an instrument for "showing degrees of weather," probably a self-recording barometer, but the description is not clear. The spindle which drives the hour-hand of the clock carries a pinion which moves a rack, long enough to pass out clear of the case on each side. At the end of the rack there is a pencil, which bears upon a disc keyed on to the spindle of the direction-vane. The disc carries a printed diagram, a series of radial lines indicating direction, the time being shown by a number of concentric circles. The irregular line drawn by the pencil records the direction of the wind. A fresh paper is placed on the instrument every twelve hours.

Whilst upon this subject, perhaps I may be allowed to call attention to a paper by Richard Lovell Edgeworth, on wind pressure, in the *Phil. Trans.* for 1783, p. 136. It contains the results of a series of experiments undertaken to determine the variations in the pressure of the wind upon surfaces of equal area, but of different forms. This is, no doubt, the paper referred to by Robinson, as the source whence he derived the

hint of his well-known "cup" anemometer, although Edgeworth only speaks of *bending* the various pieces of metal which formed the terminations of the arms of the revolving apparatus with which he was experimenting. This paper was alluded to by the president, in the course of his address to the Meteorological Society, but in such a manner as to lead me to suppose that it was not very generally known.

May I ask when, and by whom the word "anemometer" was introduced? The earliest instance of the use of the word, with which I am acquainted, is by D'Ons en Bray, in 1734. I expect that it is of French origin. RICHARD B. PROSSER

Vivisection

IT is due to Prof. Yeo to state that while enumerating in his article on Vivisection the texts which in his opinion bore most directly upon the subject, he did not omit the case of the swine to which Mr. Stevenson alludes (NATURE, vol. xxv. p. 483). I may, observe, however, that as Prof. Yeo's argument only required to cite the texts which convey the authority of our Lord, he did not make out so strong a justification of physiological method on biblical grounds as he might otherwise have done. The whole philosophy of "scape-goats" and of animal sacrifice in general, clearly rested on the assumption that the Deity considered vicarious suffering of animals for the benefit of man, not merely to be what Lord Coleridge would term "lawful," but even desirable to the extent of rendering it obligatory on man to "shed the blood" of lower creatures for the purpose of obtaining immunity from evil.

This is not the place to consider such a topic at length, but after what has already appeared in these columns it seems worth while to observe that anti-vivisectionists would show themselves most politic by not attempting to carry their controversy into the domain of biblical ethics. The uniform opinion entertained by the canonical writers touching the importance and the rights of animals in the divine scheme of things, appears to have been that which is so tersely expressed by the Jewish Apostle of the Gentiles—"Doth God take care for oxen?"

THE WRITER OF THE ARTICLE ON "VIVISECTION"

IT is with great regret that I inform you, and through you Miss Cobbe and the readers of NATURE in general, that I have been made the victim of a *ridiculous and ill-timed hoax*. The little anecdote of Miss Cobbe which appeared in NATURE, vol. xxv. p. 459, is, it appears on investigation, quite apocryphal; yet my informant, when relating it to me, asseverated its truth so strongly, and gave me so many corroborating details, that I did not hesitate in saying that "I knew it to be true." He even ventured to "name" the celebrated vivisectionist whom Miss Cobbe was supposed to have interviewed. Therefore, when doubts began to be cast on the accuracy of my statements, I communicated with this gentleman, who informed me that the whole of this conversation between himself and Miss Cobbe is *totally imaginary* and never took place. "A fellow-feeling makes us wondrous kind," and I am sure Miss Cobbe, having been so often victimised herself, and led to believe ridiculous tales of hideous and impossible torture inflicted by high-minded, scientific gentlemen, will sympathise with me in my chagrin at finding myself a victim to my own gullibility.

May I be allowed to add, Sir, a serious postscript to my letter?

We none of us—I least of all—doubt the value of Miss Cobbe's advocacy of any cause. Had not the practice of vivisection been based on an earnest seeking after knowledge, it had surely fallen ere this before Miss Cobbe's stout blows. Now whilst we are disputing as to whether the practice of vivisection be right or wrong, a far more serious question—I had well-nigh said "crime"—is confronting us. Owing to the extraordinary demand for rare (not necessarily "beautiful") birds' skins, for the adornment of women, we are threatened with the rapid, almost immediate, extinction of some of the most wonderful species of the world's avifauna. I saw, in a milliner's shop in Regent Street, the other day, four birds of paradise, two trogons, scarlet ibises by the dozen, a rare goatsucker, kingfishers, orioles, and bee-eaters, not to mention many other birds whose greater abundance might seem to excuse their wholesale sacrifice. Now, Sir, the human race has already had to mourn the destruction of the dodo, the solitaire, the great auk, and the moa: let us not add to this list the *paradiseidæ*, the trogons, and the humming-birds. If then, Miss Cobbe will only place herself at the head of an Anti-bird-skin-wearing Association, she will find one of the most grateful and humble of her followers in your obedient servant, H. H. JOHNSTON

PS.—I take this opportunity of remarking, that I have no connection whatever, in an official capacity, with the Zoological Gardens. I headed my first letter thus, merely because it accidentally happened that I borrowed pen, ink, and paper, and wrote it there.

Tudor House, Champion Hill, S.E., March 27

YOUR correspondent, Mr. C. A. Stevenson, referring to the miraculous narrative of St. Mark, chap. v., verses 26 32, reasons to the effect that if 2000 swine were destroyed to alleviate the sufferings of a single man, then are those physiologists to be justified who, for the benefit of the whole human race, sacrifice a few animals. But, unfortunately for the argument, neither from the narrative of St. Mark, nor from those in the other gospels, does it appear that the permission given to the "unclean spirits" to pass into the swine, after their expulsion from the "demoniac," in any way contributed to his cure. On the contrary, it is distinctly implied that the demons might have been sent elsewhere than into the swine. For, according to St. Mark, they "besought" that they might not be sent "away out of the country"; or, as St. Luke has it, that they might not be commanded "to go out into the deep," that is into the "abyss," elsewhere translated "bottomless pit." Thus, it seems to be taught that when driven out of the man, the demons might have become simply disembodied spirits; and, indeed, so far as we can gather, the permission to enter into the swine was purely *ex gratiâ*.

Hence any pro-vivisection argument to be sought in the fate of the swine must, I fear, assume a form differing somewhat from Mr. Stevenson's; but which I prefer not to specify.

W. S.

As no one has made any remarks upon the passage in Mr. H. H. Johnston's letter, in which "a distinguished man of science" is said to have twitted a lady with "wearing ostrich feathers which are plucked from the *living bird*, causing most exquisite pain," will you allow me to inform the fair portion of your readers that they may wear ostrich feathers with clear consciences if they can make sure of these having been taken from living birds, *i.e.* from those kept on ostrich farms. It used, I believe, to be the practice to pluck out the feathers; but the inflammation set up proved injurious or fatal, as must be obvious, and the life of a bird worth perhaps 60*l.* or 80*l.* was endangered for a crop of feathers worth 7*l.* or 8*l.* When the feather is quite ripe and at its best, the quill is cut with a pair of scissors or sharp knife about half an inch from the skin, and the stump moults out in the ordinary course. Probably by far the larger quantity of plumes come from tame birds. In 1878, 57,144 lbs. were exported from the Cape, and there are probably considerably more than half a million of tame birds in South Africa at this moment.

Ladies who carry their anti-vivisection consistency so far as to have serious misgivings about wearing leather boots, must still be cautious in the matter of ostrich feathers; since numbers of birds are hunted down for their plumes, although we can hardly suppose them in this case even to be plucked out while the ostrich is alive. They would come quite as easily from a dead but still warm bird, and the hunter would not be exposed to the risk of that tremendous kick an ostrich can give. I shall be glad to know on what authority birds of paradise are stated to be "skinned alive." ARTHUR NICOLS

Phænology—An Appeal

THE undersigned would urge all those who take an interest in the phænology of plants to make as many and as accurate observations as possible, and they recommend as specially suitable the following plants (the dates after the names give the mean for Giessen, calculated from many years). The observations should be made on plants standing free, plants on espaliers being excluded, and they should be made daily, accurate results being only obtained in this way.

A.—FIRST BUDS OPEN

1. *Ribes rubrum* (red currant)	April	14
2. *Prunus Avium* (wild cherry)	,,	19
3. *Prunus spinosa* (sloe)	,,	20

4.	*Prunus Cerasus* (dwarf cherry)	April	22
5.	*Prunus Padus* (bird cherry)	,,	24
6.	*Pyrus communis* (wild pear)	,,	23
7.	*Pyrus malus* (crab apple)	,,	28
8.	*Syringa vulgaris* (lilac)	May	4
9.	*Lonicera tatarica* (Tartarian honeysuckle) ...	,,	4
10.	*Narcissus poeticus* (poet's narcissus)	,,	5
11.	*Aesculus hippocastanum* (horse-chestnut) ...	,,	7
12.	*Cratægus oxyacantha* (hawthorn)	,,	9
13.	*Cytisus laburnum* (laburnum)	,,	15
14.	*Sarothamnus vulgaris* (common broom) ...	,,	14
15.	*Cydonia vulgaris* (common quince)	,,	16
16.	*Sorbus aucuparia* (mountain ash)	,,	17
17.	*Sambucus nigra* (common elder)	,,	28
18.	*Secale cereale* (rye)	,,	28
19.	*Atropa belladonna* (deadly nightshade) ...	,,	29
20.	*Vitis vinifera* (grape vine)	June	13
21.	*Tilia Europæa* (*grandifolia*) (lime tree) ...	,,	22
22.	*Lilium candidum* (white lily)	July	1

B.—First Fruit Ripe

23.	*Ribes rubrum*	June	21
24.	*Lonicera tatarica*	July	1
25.	*Sorbus aucuparia*	,,	30
26.	*Atropa belladonna*	Aug.	2
27.	*Sambucus nigra*	,,	11
28.	*Aesculus hippocastanum*..	Sept.	17

Observations of the species 1, 3, 8, 11, 17, 22, and 27 are specially requested, as one of the undersigned (Dr. Ihne) is at present occupied with the preparation of a phænological map for Europe. Observations made either this year or previously, but not yet published, should be sent to one of the undersigned, and will be esteemed a favour. In what way (*inter alia*) it is possible to utilise the observations, may be understood from the comparative phænological map of Central Europe, by H. Hoffmann (*Petermann's Geographische Mittheilungen*, January, 1881.)

H. Hoffmann
Egon Ihne

Giessen, February 25

Rime Cloud observed in a Balloon

In the question whether the cloud that floated over Paris, January 25, consisted of microscopical atoms of solidified water or of minutest globules of liquid water cooled below zero, discussed under this heading in Nature, vol. xxv. p. 337, 385, 436, M. de Fonvielle adduces (p. 436) in favour of the first alternative a new argument, viz. that floating over the cloud in sunshine he has seen upon the cloud only the *corona*, and nothing resembling a rainbow, and he invokes the authority of Bouguer (1744), que "le phénomène [la *corona*] ne se trace que sur les nuages formés de gouttes de vapeur et même sur ceux dont les portraits sont glacées, mais non sur les gouttes de pluie comme l'arc-en-ciel."

I did not expect anything else. M. de Fonvielle could not see a rainbow, because the cloud certainly did not consist of rain-drops; neither could he see a rainbow, when the cloud consisted of minutest particles of liquid water.

It is a well-known fact that small particles of water suspended in air produce no rainbow. When Kratzenstein (1774) advocated the opinion anticipated by Halley (1686), that water-vapour may be condensed in a vesicular state, he availed himself of the observation, that in cloud, and mists, and the condensed steam over boiling water, a rainbow is not to be observed in reflected light. It is not necessary to enter into the question whether the hypothesis of mist-vesicles is to be abandoned, and—as seems to me more probable—the existence of very small solid (*i.e.* not hollow) globules of liquid water is to be admitted for clouds, &c., consisting of the latter; solid water-drops, too, if their dimensions are small enough in comparison to a wave-length of light, cannot cannot produce a rainbow.

So I think it still possible that the cloud observed by M. de Fonvielle, and many mists, which have been described as consisting of ice, may have consisted of liquid water cooled below zero.

In my letter in Nature, vol. xxv. p. 385, read "Hildebrandsson's discussion of the meteorological observations made during the voyage of the *Vega*" for "Hildebrandsson's meteorological observations, &c."; and "Froströg" (*i.e.* frost-smoke) instead of "Frostzög."

Heidelberg, March 11 Hermann Kopp

Water in Australia

The extracts from Australian letters communicated by Mrs. Merrifield remind us again of the important question of water-supply in that thirsty region. Why need the crops be lost for lack of water, when accumulating evidence assures us that in the Tertiary Sandstone of the great central plain there is an abundant supply not many yards from the surface? How can the great gum trees resist the drought as they do unless their roots touch water? Several successful borings have already been made, but probably such works far inland are prevented by the scarcity of fuel for steam power. Prof. Ayrton has now, however, demonstrated that power can be generated wherever coal is plentiful, and transmitted economically and effectively by electric wire to the inland motors. It is probable that within a few years the dynamo machine will prove of more practical value to Australia than to any other country in the world. If there is any novelty or any value in the suggestion of an underground water-supply in the Australian plains, and of obtaining it by the aid of electricity, the credit is due to Mr. Thomas Blunt, of Baxter-gate, Loughborough, not to myself.

Bristol Hill, Leicester, March 25 F. T. Mott

The Solar Spectrum in a Hail-Storm

During the hail storm of Tuesday, the 21st inst., I made observations on the spectrum in various parts of the sky, and was surprised to find the orange lines of a tint decidedly deeper than that of their normal hue. When the hail ceased and the snow began to fall heavily, the lines assumed their usual colour. The rain-band at the time was strong, as might have been expected. I was not before aware that hail would exert this influence on the spectrum The observations were made with a small pocket spectroscope. C. H. Romanes

Worthing, March 22

Temporary Retinal Effects

In your present week's "Notes" you have referred to the curious experiences of MM. Macé de Lepinay and Nicati, in finding the town lights appear green, after five hours among snow-fields. On the Cima di Jazi, some 16,000 feet or more high, I found another effect. On removing my blue snow-glasses, the sky (at about 10 a.m.) appeared of the deepest indigo colour, while the sun could be looked at without pain, and resembled a harvest-moon close to the horizon, of a red yellow tint, and with a well-defined outline. The effect disappeared as we descended the mountain. As another instance of temporary affliction of the retina, I had been using on the sun, as examined with an 8¼-inch reflector, a miniature spectroscope with fine slit, notwithstanding which the spectrum was very bright. Some hours (not immediately) after, all the gas lamps, candles, &c., appeared of a blood red, and so continued for some hours. This effect still persisted at dinner-time, but gradually and entirely passed off during the meal. No trace of green tint was, in this case, seen. In the sun-glare it is not uncommon with some persons, to find leaves and other small objects on the path, of a red tint. J. Rand Capron

Guildown, March 25

Specific Heat and Thermal Conductivity

Prof. Tyndall, in his lectures on "Heat a Mode of Motion," p. 255, gives a highly-instructive experiment to illustrate the influence of the specific heat of a substance in masking its thermal conductivity. Short prisms of iron and bismuth, having their upper ends coated with wax, are placed upon a vessel of hot water, and the wax is observed to melt first upon the bismuth, in spite of its comparatively low conductivity.

I should like to ask whether others have been uniformly successful in obtaining the above result, at any rate when the bismuth and iron prisms are soldered to the top of the hot water vessel; for this seems to me necessary in order that the experiment may be made with absolute fairness, and independently of any want of uniformity of polish and flatness in the surfaces between which the heat has to pass.

I have tried with cylinders of nearly pure bismuth and best bar iron of various lengths (from 1 cm. to 5 cm.) and diameters, brightly polished, and in some cases wrapped in vulcanised india-rubber, to avoid loss of heat by radiation and convection, and I invariably find that the wax melts upon the iron first.

Moreover, on turning to the tables of conductivity and specific heat, I find for iron and bismuth—

	Iron.		Bismuth.
Ratio of thermal resistances	1	...	6
,, specific heats	3·7	...	1

The theoretical resultant effect would seem to be indicated by compounding these ratios, which would still leave a decided balance in favour of iron.

It seems doubtful whether the law, distance of point of equal temperature from source $\propto \sqrt{\text{conductivity}}$, holds good in the case of bad conductors, and in any case it only applies when all parts of the bar have attained a constant temperature.

I must apologise for asking for information on so small a matter, but I should especially like the experiment to succeed if Nature will kindly permit it. At the same time, I hope that I shall not be accused of undue pessimism if I say that, according to my experience, the work of a natural science lecturer is simply a perpetual struggle against the malice of Nature.

Eton College, March 18 H. G. MADAN

Rookeries

CAN any of your readers kindly inform me how to establish a *rookery*. I have tried putting old nests into high elm trees, but they have not been taken to, although rooks are often in the trees. THE MUG

Truelove's, Ingatestone, Essex, March 21

A Means of Saving some Lives in Colliery Explosions

WHATEVER brings about an explosion in a colliery, it appears that men often perish thereby not from burning, nor from injury, but from want of fresh air. It would now be easy, or might soon become so, for every collier, at a small cost, to keep near him always when at work, a little vessel full of compressed air, which being provided with a rather fine nozzle, and a stop-cock, and a small piece of india-rubber tube, might be a sufficient deliverance for him in the moment of need, should he in an explosion have escaped violent injuries. D. RHYS JONES

Carmarthen, March 24

ECONOMIC GEOLOGY OF INDIA[1]

I. *Precious Stones and Metals*

THE concluding volume of the Manual of the Geology of India was issued from the Calcutta Press towards the last days of 1881, and a supply of copies may now any day be expected to arrive in London. This volume, published by order of the Government of India, brings to a worthy conclusion a most remarkable work, in which we find a general geological sketch map of nearly the whole of India, a descriptive account of its various formations, and a history of those geological products therein found which are of importance to mankind. When we stop to think of the immense area explored, of the enormous amount of details that had to be collected and sorted, of the dangers and trials which were encountered during the investigation of much of the country that had to be explored, we confess to being struck with amazement at the energy, zeal, and courage of the comparatively very small staff employed by our Government in this service, and we feel sure that those labouring in European or American fields will be the first to acknowledge how much is owing to the Geological Survey of India for the quality as well as the quantity of the work done by them in the plains of Asia.

But it is not only the geologists that will find an interest in this the third volume of the Manual. It treats of the economic products of the geological formations of India, and has a far greater interest even for the statesman than for the scientific man, and an interest too for the commercial man and the general reader, nay even more, there is much of interest in this volume for the student of history, for the student of mankind, about the origin of myths, and about the gradual development of the arts of working in iron and gold.

This volume is written by Prof. Valentine Ball, who was, until recently, officiating deputy Superintendent of the Geological Survey of India; an author well known by his pleasant record of many years' work in India, not long since published under the title of "Jungle Life in India," and one who, by many years' assiduous and patient labour as one of the Survey Staff, was fully qualified for the great task so well accomplished in this work. Not only has he brought together in this volume a great store of facts collected by others, but from his own personal knowledge of localities and details, he has been enabled to arrange these facts in orderly sequence in a way few others could have attempted, and he well deserves the high commendation of his chief, the Superintendent of the Survey, who writes: "The student, as well as the man of enterprise, will long owe him gratitude for what he has thus brought within their easy reference."

To give our readers an idea of the contents of this volume, we propose to treat of them in a somewhat arbitrary fashion. In this notice we would call their attention to the Precious Stones and Metals of the East. In a second notice to treat of its Iron and Coal resources, and of the important subjects of its Salt supply and Building Stones. It will not be in any sense our object to treat these subjects in an exhaustive manner, but to indicate to the reader what he will find in the 600 large octavo pages of this work, which is illustrated with numerous maps, lithographic plates, and woodcuts.

The diamond is the most important of the precious stones of India; it can be traced back to Sanscrit literature, in which the first mention of its actual localities is to be found. The famous Koh-i-nur is stated to have belonged to Karna, the King of Anga, about 5000 years ago; but this is not founded on any very reliable evidence. Tavernier and Marco Polo allude to a trade existing in diamonds between Asia and Europe, and before the first diamond mines in Brazil were opened (1728) nearly the whole supply of the old world went from India. There are in India three extensive tracts, widely separated from each other, in which the diamond is known to occur. Besides these principal tracts there are others where diamonds have been found, but precise details are wanting. The most southern of the three great districts has long borne the familiar name of Golconda, though Golconda itself never produced diamonds, and is in fact merely the mart where they were sold and bought. In this southern tract, which is in the Madras Presidency, either are or have been the mines of Kadapah, Bellary, Karnul, Kistna, and Godavari. The second great tract occupies a considerable area between the Mahanadi and Godavari rivers. The third is situated in Bundelkhand, near one of the chief towns of which, Panná, some of the principal mines are situated. In Northern India the diamonds, when found *in situ*, are in a conglomerate which is referred to the Rewah group of the Upper Vindhyan formation, while in Madras they are found under the same circumstances in the Banaganpilly sandstones, which form the base of the Karnul formation.

In connection with this geological position it is interesting to note that these Vindhyan rocks of India have been correlated with the diamond-bearing rocks of the Cape Colony in Africa. The examination of the diamond-bearing strata of India seems to throw no light on the as yet unsettled question of the conditions under which the crystallisation of carbon took place, which resulted in the formation of this precious gem, though synthetical operations in the laboratory seem to tend towards confirming Liebig's view, that it has been formed by crystallisation from a liquid hydrocarbon. It must however be remem-

[1] "A Manual of the Geology of India. Part III. Economic Geology." By V. Ball, M.A., F.G.S., Officiating Deputy Superintendent, Geological Survey of India. Published by order of the Government of India. (Calcutta, 1881.)

bered, in treating of this part of the subject, that it is still a matter for doubt if the diamond in India has ever been found in its *original* matrix. The lowest diamond-bearing stratum at the base of the Karnul series is itself a detrital conglomerate, and it is not unreasonable to suppose that the diamonds in it may, like the other ingredients, have been derived from some older metamorphosed rocks.

Very copious details are given as to the various mines and as to their respective produce. The history of the great Mogul diamond is narrated, and the conclusion come to that it is probably now in part represented by the Koh-i-nur. As a practical application of known facts, the prospect of diamond mining in India under European direction is dismissed as unprofitable. With scientific guidance, backed by capital and proper mining appliances, it might at first appear that mining by Europeans ought to succeed, but on a closer investigation it will be gathered that there are in diamond-mining certain peculiarities which distinguish it from most, if not all, other forms of commercial enterprise; and as a principal of these the facilities for peculation in consequence of the readiness with which the gem can be secreted, must be reckoned. Furthermore, it would almost seem that, except under a system of slavery, the diamond cannot be worked profitably in India. The present system, though not so called, practically amounts to slavery; the actual miners are by advances bound hand and foot to the farmer of the mines, and these are content to wait for months together without any return; their outlay being very small, and there being no heavy expenditure of capital required.

The myth regarding diamond-seeking, made so familiar to every one by the travels of Marco Polo and Sindbad the Sailor is of great antiquity.

"Perhaps one of the best accounts of it is by Nicolo Conti, who travelled in India in the early part of the fifteenth century. He says that at a place called Albenigaras, fifteen days' journey north of Bizengulia, there is a mountain which produces diamonds. This Albenigaras might be Beiragarh, the modern Wairagarh; that it was so is doubtful, but its identity is perhaps immaterial. Marco Polo undoubtedly referred to the localities in the Kistna Valley. Nicolo Conti says that the mountain being infested with serpents it is inaccessible, but is commanded by another mountain somewhat higher. 'Here at a certain period of the year men bring oxen which they drive to the top, and having cut them into pieces cast the warm and bleeding fragments upon the summit of the other mountain by means of machines which they construct for the purpose. The diamonds stick to these pieces of flesh. Then come vultures and eagles flying to the spot, which seizing the meat for their food fly away with it to places where they may be safe from the serpents. To these places the men afterwards come and collect the diamonds which have fallen from the flesh.' He continues with an account of how other less precious stones are obtained, and this part of his description is that of ordinary Indian diamond-mining. Allusion has been made to the native belief that the diamond mines were under the special patronage of the goddess Lakshmi, and that sacrifices were made to propitiate her. There is reason for believing that sacrifices were made on the opening of new mines, and probably also when the supply of diamonds ran short.

"The late Mr. M. Fryar, when visiting a stream-tin washing at Maleewoon, in Tenasserim, was requested first to remove his boots, being told that on a former occasion a European visitor insisted on walking up to the stream with his boots on, and that in consequence it ceased to yield ore until two buffaloes had been sacrificed to appease the insulted guardian spirits of the place.

"This is scarcely a suitable place for fully illustrating this subject, but the following, if put side by side with Nicolo Conti's account, so completely explains it that it will perhaps be sufficient for present purposes.

"Dr. J. Anderson, in his recent report on the expedition to Yunan, describes having witnessed the sacrifice of two buffaloes by the Kakhyens to the Nâts or evil spirits. The animals having been slaughtered on two bamboo altars were cut up and the meat distributed, *certain portions with cooked rice being placed on a lofty bamboo scaffolding for the use of the Nâts.* It goes without saying that birds would help themselves to these offerings.

"Credulous travellers in early times might very possibly have supposed, on witnessing such a preliminary sacrificial rite, if at a diamond mine, that it was an essential part in the search for diamonds, and it would not require any very great stretch of Oriental imagination to build up the fable on such a substratum of fact. The bamboo scaffolding in all probability represents the machine mentioned by Conti."

Graphite or plumbago, as found native, contains from 90 to 99 per cent. of carbon. The only deposit in India, with the possible exception of another at Vizagapatam, which seems of any present promise is that which occurs over a wide tract in Travancore. At the present day nearly all the plumbago of commerce comes from Ceylon.

Of the precious metals Platinum occurs in very minute quantities, with gold-dust, and has been probably derived from metamorphic rocks.

Silver is found associated with gold, and in combination with sulphur, and as a sulphide it is often associated with sulphide of lead, antimony, &c., but the amount of silver produced over the peninsula is very small.

Gold is met with very generally distributed over British India. The ultimate derivation of most of the gold of Peninsular India, is doubtless from the quartz reefs which occur, traversing the metamorphic and submetamorphic series of rocks; but there is also evidence to show that in some parts of the country gold occurs in certain chloritic schists and quartzites, and possibly also in some forms of gneiss, independently of quartz veins. As to the relative productiveness of the reefs in the different groups or series of metamorphosed rocks, the imperfect evidence which at present exists is somewhat conflicting, the truth probably being that no one rule holds applicable to the whole of the country. The presence of gold, either as an original deposit, or as a detrital product from the older rocks, has not as yet been proved in any member of the great Vindhyan formation; but in the next succeeding formation several of the groups included in the Gondwana system are believed to contain detrital gold; of these the evidence seems clearest in the case of the Talchir. It is almost certain that the gold obtained in the Godavari, near Godalore, is derived from rocks of Kamthi age, and the gold of the Ouli River, in Talchir in Orissa, is derived from sandstones. The only other sources in Peninsular India are the recent and sub-recent alluvial deposits, which rest on metamorphic or sub-metamorphic rocks. In the Extra Peninsula districts gold is met with in rocks of several different periods. In Ladak certain quartz reefs, which traverse rocks of the Carboniferous period are gold-bearing. In Kandahar gold occurs in rocks of Cretaceous age, and the deposit seems to be an original one, connected with an intrusion of granite. Lastly, all along the foot of the Himalayas, from west to east, from Afghanistan to the frontiers of Assam and Burma, the tertiary rocks which flank the bases of the hills, and which occur also in the Salt Range, and at Assam, south of the Bhramaputra, are more or less auriferous, but the gold is detrital.

The history of gold mining in India is lost in a very remote antiquity. Vast amounts of bullion were carried away by the Moslem armies of the fourteenth century. Some would place the Ophir of King Solomon on the west coast of India, and much of this precious metal as has been already collected from the golden sands of the

peninsula, it is possible that much more remains. Quite recently the gold fields of Madras have attracted a great deal of public interest, and a large amount of capital is being diverted to their exploration. For writing a history of British gold mining in India the time has not yet come, and we can only hope with Prof. Ball "that the actual results of this enterprise may come up to the high standard of success which has been predicted for it."

Amidst a variety of most interesting details as to the various gold diggings and gold workings in India, we select the following account of the Thibetan Gold Mines, which for many centuries and to the present day, send a regular supply of gold to India.

"Of the very highest interest are the accounts of the Thibetan gold mines, which are given by the Pundits attached to the Indian Survey for the purpose of exploring countries north of the Himalayas. Unwittingly these admirable native servants of the Government of India have furnished facts which have enabled Sir Henry Rawlinson, and independently Prof. Frederic Schiern, Professor of History at the University of Copenhagen, to clear up a mystery which has been a puzzle to the historians and philosophers of many countries for upwards of 2000 years. A translation of Prof. Schiern's paper,[1] by Anna M. H. Childers, will be found in the 'Indian Antiquary.[2] It is a most remarkable example of learned research, and one very difficult to give in abstract. It is entitled 'The Tradition of the Gold-digging Ants.' But perhaps before giving the conclusions which Sir Henry Rawlinson and Prof. Schiern have arrived at, it will be best in this place to briefly describe the Pundits' observations :—

'During the expedition of 1867 the Pundit who had been at Lassa fell in at Thok Jalung, an important goldfield in the province of Nari Khorsam, with a large encampment of Thibetan miners, and took the opportunity to gain information relative to the working of the mines. In the third expedition, in 1868, another Pundit passed on as far as Rudok, at the north-west extremity of Chinese Thibet on the frontier of Ladak, and on his way back from Rudok visited the gold-fields of Thok Nianmo, Thok Sarlung,[3] and Thok Jarlung. The map which accompanies Major Montgomery's narrative of the journeys of the Pundits gives in addition the gold-fields of Thok Munnak, Thok Ragyok, Thok Ragung, and Thok Dalung.' . . . . 'The miners' camp at Thok Jarlung, according to the measurements of the Pundits, is 16,300 feet above the sea-level.

'The cold is intense, and the miners in winter are thickly clad in furs.

'The miners do not merely remain under ground when at work, but their small black tents, which are made of a felt-like material, manufactured from the hair of the Yak, are set in a series of pits, with steps leading down to them . . . seven or eight feet below the surface of the ground.' 'Spite of the cold the diggers prefer working in winter; and the number of their tents, which in summer amounts to 300, rises to nearly 600 in winter. They prefer the winter, as the frozen soil then stands well, and is not likely to trouble them much by falling in.'

"They are occasionally attacked by bands of robbers, who carry off their gold.

"Sir Henry Rawlinson's remarks on these reports of the Pundits' researches and travels are as follows :[4]—

"'Now, then, for the first time, we have an explanation of the circumstances under which so large a quantity of gold is, as is well known to be the case, exported to the west from Khoten, and finds its way into India from Thibet; and it is probable that the search for gold in this region has been going on from a very remote antiquity, since no one can read the ex-Pundit's account of Thibetan miners 'living in tents some seven or eight feet below the surface of the ground, and collecting the excavated earth in heaps previous to washing the gold out of the soil,' without being reminded of the description which Herodotus gives of the 'ants in the lands of the Indians bordering on Kaspatyrus (or Kashmir) which made their dwellings underground, and threw up sand heaps as they burrowed, the sand which they threw up being full of gold.'

"Prof. Schiern points out that the tradition was mentioned in writings of the middle ages, and those by Arabian authors It survived among the Turks. Strabo and Albertus Magnus treated the whole story as a fiction. Xivrey supposed that the animals had become extinct owing to the *auri sacra fames*. Major Rennell supposed that the dwellers in mounds were *termites* or white ants. Humboldt's observations in Mexico on the habit of certain ants to carry about shining particles of hyalith was quoted by those who believed that the animals were really ants. Other authorities suggested that they were marmots, jackals, foxes, or hyænas. Pliny having stated that horns of the Indian ant were preserved in the temple of Hercules at Erythræ, Samuel Wahl, who maintained the hyæna theory, proved equal to the difficulty by suggesting that the horns might have been a *lusus naturæ*. Prof. Schiern ingeniously argued that the horns had been taken from the skins of animals which formed the garments of the miners. It seems possible, however, that they were samples of the pickaxes made of sheep's horns, which, as is mentioned above, are used to the present day by the miners in Ladak.

"Prof. Schiern further points out that ancient writers say that the ants worked chiefly in winter, and connects this with the statement of the Pundit above quoted.

"In conclusion he writes :—

"'For us the story partakes no longer of the marvellous. The gold-digging ants were originally neither real ants, as the ancients supposed, nor, as many eminent men of learning have supposed, larger animals mistaken for ants on account of their subterranean habits, but men of flesh and blood, and these men Thibetan miners, whose mode of life and dress were in the remotest antiquity exactly what they are at the present day.'"

The quotations that we have given will show the general reader what he may expect to find in this volume, in addition to the more scientific accounts of the several diamond and gold mines.

(*To be continued.*)

[1] Verhand Kgl Danischen Gesellsch. der Wissensch for 1870. Printed separately in Danish, German, and French.

[2] Vol. iv. p. 225.

[3] Thok Sarlung had at one time been the chief gold-field of the district, "but had in a great measure been abandoned on the discovery of the Thok Jarlung gold-field. The Pundit passed a great excavation some 30 to 40 feet deep, 200 feet in width, and two miles in length, from which the gold had been extracted."—*Jour.* As. Soc., Bengal, vol. xxxix., Pt. 2, p. 53. 1870

[4] *Pall Mall Gazette*, March 16, 1869, quoted in "Indian Antiquary," p. 225.

PRECIOUS CORAL

WHILST preparing a set of lectures on Corals, lately delivered at the Royal Institution, I made some inquiries as to the present state of the fisheries of precious coral from Messrs. Greck and Co., coral merchants, of Rathbone Place, who also have an establishment at Naples. They exhibited a very fine series of examples of raw and worked coral at one of my lectures, and also sent me the following short notes on the Italian and Sicilian coral fisheries, partly taken from an Italian newspaper, but which contain some facts which may be interesting to the readers of NATURE. I was shown a large number of the Sciacca specimens, all attached to groups of bivalve shells or pieces of dead coral. The blackened coral is described by Lacaze Duthiers in his famous monograph as "corail noirci dans la vase." It is very possible that the blackening substance is binoxide of manganese, since we dredged, in deep water during the *Challenger* Expedi-

tion, large quantities of a dead coral skeleton, apparently allied to Corallium, which was blackened by that substance. It is in the hope of eliciting some definite information from the readers of NATURE concerning the so-called Japanese Corallium that I send the present notes. At a late meeting of the Zoological Society, Mr. G. O. Ridley, of the British Museum, read a paper on the Coraliidæ, and reviewed the species known, and exhibited specimens of the form said to come from Japan. I obtained specimens of this corallium from Mr. Cutter, the London dealer, from whom I first learned that a precious coral was called Japanese. He told me that he had seen a large quantity in the market in London, but that it would not fetch any price, whereas Messrs. Greck state that Japanese coral sold for an extremely high price in Italy. Messrs. Phillips, of Cockspur Street, who also exhibited a fine series of specimens of precious coral at one of my lectures, showed amongst them a carved jewel cut out of Japanese coral, which is remarkable as being of mixed colour, marbled white and red, and also, as they informed me, for its far greater hardness than ordinary precious coral.

Now although this coral, which is of a named species, is evidently universally regarded in the trade as Japanese, all evidence available seems to prove that no precious coral occurs in Japan. The *Challenger* did not meet with any ; and though I inquired, I heard of none as dredged there. Moreover, in numerous Japanese illustrated works on the races of men, certain foreigners of some kind are represented as bearing in their hands precious coral as tribute, or as the staple produce of their country, thus showing apparently that the coral is regarded as something rare from abroad in Japan. Perhaps, some of the correspondents of NATURE in Japan can state whether any corallium occurs in Japanese waters. H. N. MOSELEY

Extract from the letter of Messrs. Greck and Co. :—

"Coral fisheries on the coasts of Italy and Sicily begin about the middle of February, and continue till the middle of October. The value of the coral fished up varies immensely according to its colour and size ; the pale pink is the most prized, especially if it be of a uniform colour throughout, without stains. Off Torre del Greco, near Naples, a large quantity of coral is found every year ; from 400 to 600 boats are sent out in search of it, each boat being of from six to ten tons' burden, with a crew of at least twelve men, and costing from 500*l.* to 600*l.* a boat. Nearly all the inhabitants of Torre del Greco are employed by this industry, either as fishermen or in the manufacture of the coral brought to shore. The valuable pink coral is found chiefly off the coast of Sicily : in the year 1873 a bed was discovered in the Straits of Messina, in which the coral, though found only in small quantities and of a small size, was of immense value, owing to its beautiful pink, of a uniform colour, and without any of those stains which detract so much from its worth. The coral found in this place is sent chiefly to London and Birmingham ; it is usually manufactured in the shape of 'lentils,' and in this form is largely used for rings, either set singly in half-hoops or surrounded by precious stones and pearls. Its value varies from 80*l.* to upwards of 200*l.* per ounce.

"Unfortunately the supply of coral in this bed seems to have run short, and for the last few years coral-merchants have not found it worth their while to send boats in search of it. The last attempt was made last year by the firms of Criscuolo and Greck and Co, who despatched two boats with a crew of thirty selected men, but the find was so small as barely to pay the expenses of the outfit.

"This year out of 800 boats employed in the coral-fishery off the coast of Sicily, not one has been sent to the bed in the Straits of Messina. In 1875 a local bed was discovered about twenty miles off the coast of Sciacca in Sicily, which was invaded for the next two years by 700 boats. This number of boats all crowded together in one spot, caused great confusion, and the Italian Government despatched a man of war to keep order among the fishermen. Another similar bed was discovered in 1878, about ten miles further from the coast, and in 1880 yet another still further, to which 600 boats were sent, and we learn from the reports of the Custom House at Sciacca that in a few months about 8000 tons were fished, and although the quality of the coral is very inferior, being of a reddish colour and often quite black, its value is computed at several millions of pounds. The coral found off the coast of Sciacca does not grow as at other places attached to rocks, but is found clinging to any small object it can lay hold of, such as a shell, or a fragment of coral. It is supposed that its dark red or black colour is caused by the muddiness of the water in which it lives, although the depth of the sea at such spots is from 300 to 450 feet. This coral is not much esteemed in the English market, but is prepared in large quantities for the Indian market at Calcutta, by being exposed for months to the heat of the sun, and by being kept moist, when in time the black colour gradually disappears.

"A few years ago a large quantity of Japanese coral found its way into the market at Naples, and fetched as much as 150*l.* the kilo. in raw branches, in spite of its being a bad colour and somewhat cloudy. This high price was given on account of its extraordinary size. It is the largest real coral ever known. Nothing has been heard of it since, excepting that the fishery was prohibited in Japan."

MAXIM'S SELF-ACTING FIRE-EXTINGUISHERS[1]

HOWEVER certain it is that fires in theatres will never be completely suppressed, we may still hope by energetic measures and systematic arrangements to lessen both their number and their danger, and it is scarcely probable that we shall ever again have to record such a catastrophe as that of the theatre at Nice or the Ring Theatre at Vienna. The preventive measures to be taken against a dangerous fire which may break forth at any moment are twofold—moral and material. The moral measures unfortunately do not admit of immediate or easy application. The public must be educated, and, as it were, familiarised with the danger, by being shown the precautions taken, the most direct escape available in case of fire, so as to avoid or rather diminish the terrible results due to the crush of a mass of frantic people precipitating themselves at the same moment into the outlets during the frightful struggle for life which accompanies the slightest panic. In short, the instinct of self-preservation must be so methodised as to be rendered most efficacious. Lamps, notices to indicate the way out, widening the passages and corridors, increasing the number of outlets and staircases, &c., are all useful measures which are now being actively carried out.

In addition to these measures, whose special object is to lessen the number of victims, when it is impossible to stay the progress of the fire, there are others directed against the fire itself, by checking its advance, or strangling it, as it were, in its very birth. The stage is undoubtedly the most dangerous point, from the very nature of the materials composing it. With the decorations constantly exposed to blazing jets, it seems miraculous that accidents are not more frequent, and it is therefore upon the stage principally that the measures for fire-extinction are to be brought to bear ; it is also important that they act instantly ; for it is always more easy to obtain the mastery over a fire towards its commencement, before it has had time to develop into an incurable evil. The remedy, moreover, will often come too late, if its application depends on those who are on the stage, because they themselves, frequently under the influence of

[1] From *La Nature*.

premature panic, or being too remote from the point attacked by the fire, reach it only too late to arrest its progress.

Under those circumstances M. Maxim thought it advisable to make use of *self-acting* measures; and for that purpose has formed a combination of very ingenious appliances, the principle of which he now proposes to explain. M. Maxim's proposal is to institute such a preventive system that, as soon as a fire begins to show itself at any given point of the stage, the accident will itself produce automatically and instantaneously a series of mechanical movements sufficient to flood the threatened part with water, and arrest the progress of the fire. These movements are produced either by the mechanical action of

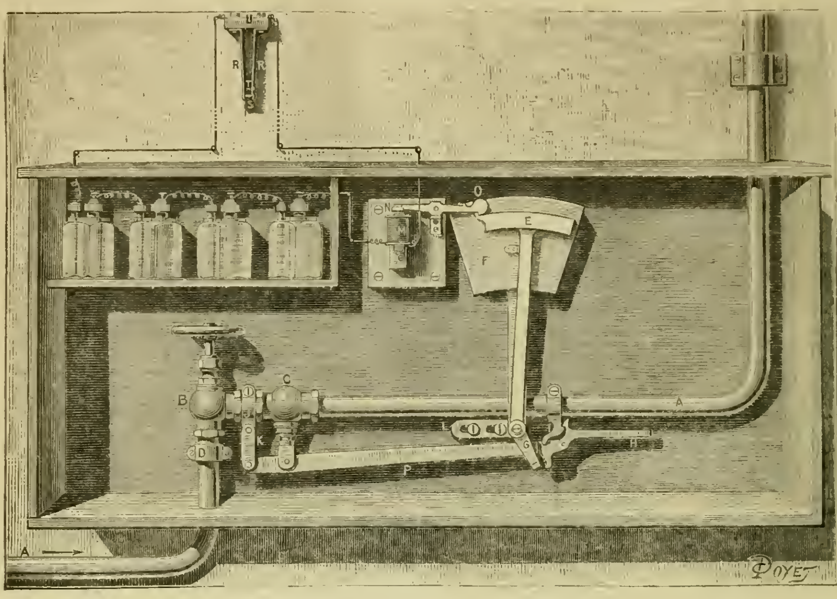


Fig. 1.—Apparatus closing the circuit and opening the tap.

levers, or by electricity; and we proceed to examine the two systems separately.

Mechanical System.—The part over the stage, and the spaces beneath it, the side-wings, and the ceiling-decorations, are traversed by a network of pipes of different diameters suitably distributed. These pipes are all connected with a common pipe in communication with the main water-supply of the town. In the usual condition, the system of pipes about the stage is full of air slightly compressed, and the supply-cock is closed. At regular intervals cocks are placed on the pipes and kept also closed by means of small levers, each of which is held in position by a string drawn tight, and fastened to a point at a suitable distance from the corresponding escape-cock. As soon as the fire shows itself at any given point, by the burning of one or more of the strings, the levers are set free, and thus open the corresponding escape-cock, and allow the compressed air to escape from the system of pipes. This depression of the compressed air lowers a valve, which sets free a weight acting on the supply-cock. The latter being thus opened, the water from the main passes throughout the system of pipes, and is at once discharged by the openings corresponding to the strings which have been burned. Thanks to this arrangement, a simple movement, caused by the rupture of a combustible string, is sufficient to act upon all the discharge-cocks, flood the part which is in danger, and prevent the fire from spreading.

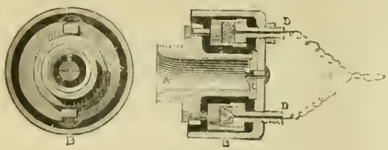


Fig. 2.—Opening of a pipe by burning a string.

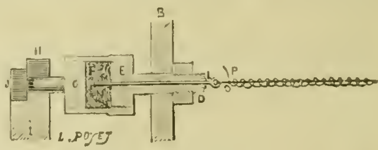


Fig. 3.—Opening of a pipe by the passage of a current of electricity.

To cause a discharge of water at any given point, M. Maxim also makes use of short combustible strings, so hanging, that when set on fire they cause an explosion of a little gun-cotton placed in a sort of a cap, which shuts

the mouth of the discharge-pipe. The cap being blown off, the air escapes, and thus, by the arrangements already described, the water discharges by the opening made by the explosion. This string-arrangement, however, is not free from objections. In scene-shifting, for example, some of the strings might be broken, opening the discharge-cocks, and thus flooding the men employed, and causing a false alarm and useless waste. That objection is entirely avoided by the electric system.

Electric System.—In this self-acting extinguishing apparatus, the network of pipes is the same as in the mechanical system, but they are not filled with compressed air. The system, as a whole, is composed of three distinct parts:—(1) an apparatus which completes the electric circuit, under the action of the raising of temperature caused by the fire; (2) a self-acting supply-cock, to send water into the system of pipes from the main pipe in the street; (3) an arrangement for opening the discharge-pipes upon any part which is in danger.

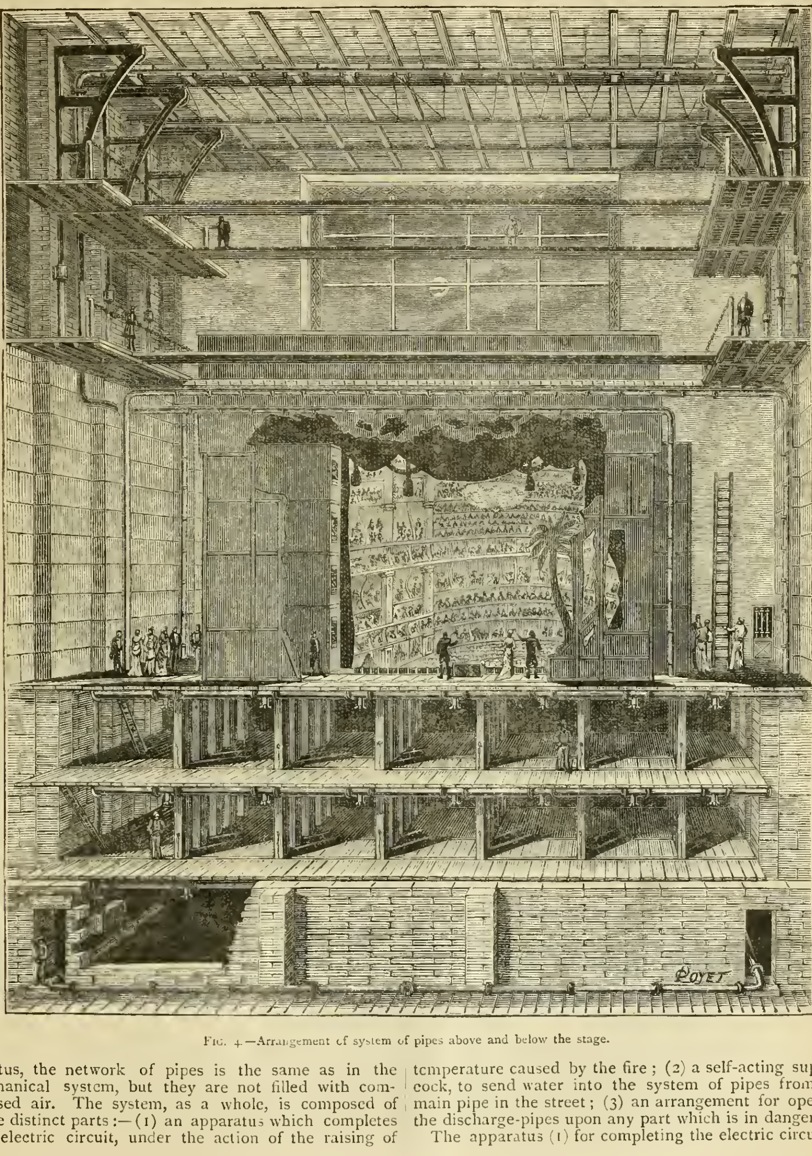


FIG. 4.—Arrangement of system of pipes above and below the stage.

The apparatus (1) for completing the electric circuit is

extremely simple. It is composed (Fig. 1) of two metallic plates, R, R, forming springs, and separated by a small piece of fusible metal, S, which is isolated from the plates by paper, or any other isolating body. The heat caused by the fire melts the metal, and the plates coming into contact, the electric acts upon the automatic supply-cock. This self-acting supply-cock (Fig. 1) is composed of an electro-magnet, M, which, under the action of the current, becomes active, and attracts the arm N, thus setting free the lever, E. The weight, F, then turns from right to left, and, after describing the quarter of a circle, falls upon the lever, H, whilst the part, G, removes a check which has kept the lever, P, in position. Under the action of the weight, F, and by means of the lever, P, which has its fulcrum in the point, J, the supply-cock, C, is turned, and the water rushes into the pipe, A, to be discharged above. The cock at B, which is worked by hand, serves to stop the supply when the fire is extinguished, or when repairs are being made. Under ordinary circumstances, it must be always open, else the action of the automatic supply-cock would be of no effect.

The water pouring upwards into the pipes ought to be discharged at the point where the fire appears. Ordinary perforated pipes may be used, but it is preferable to localise the discharge of water by the explosion of gun-cotton. This is produced (Fig. 2) either by the inflammation of very combustible strings K, which set fire through D to some gun-cotton placed in the small pistons B; or electrically (Fig. 3) by a fine platinum wire N being rendered incandescent by the current, and thus exploding the gun-cotton. For this purpose the two conducting wires O and P are separated by an insulating combustible matter and a fusible conductor, resembling those of M. Charpentier. The increase of temperature accordingly completes the circuit and causes the explosion. When there is no public supply of water, as in small towns, M. Maxim would then utilise the electric current as follows:— The weight F (Fig. 1) when set free falls on a bottle of sulphuric acid placed over a reservoir half filled with water, containing a certain proportion of lime. A large quantity of carbonic acid being thus produced in a closed reservoir, the pressure forces the water into the system of pipes. Fig. 4, the section of a large theatre, shows how the system of pipes may be disposed around the stage. Such, substantially, are the principles of M. Maxim's apparatus for preventing fires in theatres and places where people assemble in numbers, such as large warehouses, hotels, &c.

Taking the most impartial view of the advantages to be gained by this apparatus, we hope it will soon be submitted to the test of experience, while desiring there may never be any occasion of making its effectiveness too prominent.

ART METAL WORK OF JAPAN

FOR centuries past the artists of Japan have earned for themselves a reputation for their skill in the working of metals, and at the present day their productions in bronze, iron and steel, excite admiration and astonishment. This art industry is of extreme antiquity. Mr. Satow, in his recent handbook of Central and Northern Japan, describes the colossal image of Buddha at Nara It was first cast in 749 A.D., and was set up in its present position. It suffered from various accidents, and in 1567 the temple was burned to the ground, the head of the image falling off. It was replaced not long afterwards, and we may therefore assign to the body an age of 1140 years, and to the head about 300 years. Buddha is represented seated cross-legged on a dais which is of bronze, and represents the calyx of a lotus. The figure is 53½ feet high; the face is 16 feet long, and 9½ wide, while 966 curls adorn the head, around which is a halo 78 feet in diameter, on which are images 8 feet in length. A roof protects the image, and a staging is erected to assist visitors in examining it. The casting is said to have been attempted seven times before it was accomplished, and 3000 tons of charcoal were used in the operation. The whole is said to weigh 450 tons, and the alloy is composed of:—

Gold	500 lbs.
Mercury	1,954 ,,
Tin	16,827 ,,
Copper	986,080 ,,

"The body of the image and all the most ancient part of the lotus flowers on which it is seated are apparently formed of plates of bronze 10 inches by 12, soldered together, except the modern parts, which are much larger castings. A peculiar method of construction is said to have been adopted, namely, of gradually building up the walls of the mould as the lower part of the casting cooled, instead of constructing the whole mould first, and then making the casting in a single piece." The other large image of Dai Butsu at Kamakura, near Yokohama, is somewhat smaller than this, and dates from a period three centuries more recent. The various temple bells, some of which are of great size, are remarkable for the sweetness and mellowness of their tones, which contrast greatly with the harsh, clanging sounds to which we are accustomed in Europe. They are struck on the outside by huge pine beams which are suspended by strong ropes. The vessels ordinarily used in worship, such as vases, lamps, and incense-burners, are also of bronze, many of them being fine specimens of art, executed in high relief, and finished with much care. The demand for art metal work of a high order has thus existed for centuries in Japan; and so far as can be judged from the specimens of more modern work of this description, the hand of the Japanese workman has not lost its cunning. In the Japanese Art-Gallery in Grafton Street, among many rare and beautiful productions of the Land of the Rising Sun, the metal work well deserves attention. A pair of dark green-tinted bronze vases, fourteen inches high, inlaid with gold, are conspicuous for beauty of design and workmanship. They are said to have occupied the maker seven years, and their curious tint is said to be a trade secret. It must be understood that it is no mere surface colouring, but is produced by the mixture of the metals in certain proportions. The work on the rims and necks represent in gold inlay a cloud dragon, while the bodies are decorated with four medallions formed of gold and silver inlays, the shading obtained by an inlay of gold upon silver being very remarkable. The tints of bronzes vary in colour and depth from yellow, green, and ruddy to dark brown, and next to beauty of design, the tint is a *sine quâ non*. A favourite design on bronzes is the dragon, a subject which is treated with much force and character.

A plaque of *Shakudo*—an alloy of gold and copper, and black in colour—set in a bronze mounting, representing the bamboo, is remarkable as showing the care and labour expended by the Japanese artist in working out details. The design represents a meeting between the twelve chief disciples of Buddha; the inlaying of the figures, trees, flowers, &c., is of gold and silver, with various tinted compositions, and stands out from the dark background of the alloy with much brilliancy. One of the compositions employed for shading is called *shibu-ichi*, and consists of three parts of copper to one of silver. Both these alloys are favourite compositions of the Japanese artist. The minute interlaying of gold and silver in another plaque, about eighteen inches in diameter, with a curvilinear border, exhibits marvellous skill. The body of the plaque is of iron, and the border is adorned with grape-leaf and fruit patterns, the former being of gold, the latter of silver. This is the work of Komai, of Kioto, whose family held the office of sword-mounters to the Court. Swords in the olden time

were much prized by their owners, for the quality and temper of the steel, and much cost was lavished on the ornaments of the handles and sheaths. The making of a good sword was regarded as a very serious task, and the maker had to conform to certain rules of conduct from the commencement to the end of the operation. The external ornaments offered endless scope to the skill and care of the worker in metals. Great importance is attached to the maker's name, which is engraved above the guard. It was a common saying of the Japanese, that the swords of celebrated makers, such as Naminohira Yukiyasu, Masamune, and others, could not return to their scabbards, unless they had been dipped in blood; the sword maker's occupation is now gone, not so their fellow-artists, the sword-mounters. Their skill in working metals can always be turned to good account.

Many other works in metal in the gallery deserve mention, but we cannot refer to them here. They all exhibit the patience, skill, imagination, and love of his craft which distinguished the Japanese artist of old. It is to be feared that he is now abandoning these qualities, and seeking a more rapid road to fortune by shoddy foreign imitations, and that beautiful works requiring the patience and loving care of years—such, for instance, as the small cabinet shown in Grafton Street, which was made for the third Shôgun of the last dynasty, and which is probably the finest work of its kind in existence—will soon be things of the past.

ELECTRICITY AT THE CRYSTAL PALACE

III. *Land Telegraphy.*

HAVING regard to the leading part played by our country in the rise and development of the telegraph, it was only to be expected that the display of historical apparatus at the Crystal Palace should be a very good one. Thanks to the antiquarian zeal of Mr. W. H. Preece, F.R.S., and his active interest in all that pertains to the history of his profession, the Post Office has become the careful custodian of all the early telegraphs employed in England, and the stall of H.M. Postmaster General is rich in these relics of the past. Indeed, there is the nucleus here of an interesting museum of telegraphic apparatus; and it is to be hoped that such a museum will one day be established. The Society of Telegraph Engineers and Electricians have now their Ronald's Library of Electrical Works, which is practically open to all inquirers. A public museum of electrical appliances, rendered historical by the lapse of time, would be a supplementary institution of inestimable value.

One of the most interesting of these relics is the 1816 telegraph of Sir Francis Ronald himself, kindly lent by Mr. Latimer Clark, together with a portion of the copper conductor which Ronald threaded through a glass tube, protected by a wooden trough, and buried in his garden at Hammersmith. It was a frictional electric telegraph, and indicated letters by the divergence of two pith balls, after a plan somewhat similar to the suggestion of "C.M." in the *Scots Magazine* for 1759. This device is fully described in Ronald's "Electrical Telegraph," 1836, the first work published in England on the subject. A copy of this work is possessed by Mr. Latimer Clark, who we may also mention has lately acquired a forgotten book on the history of telegraphs (non-electrical), published in 1797 for the author, Mr. J. Gamble

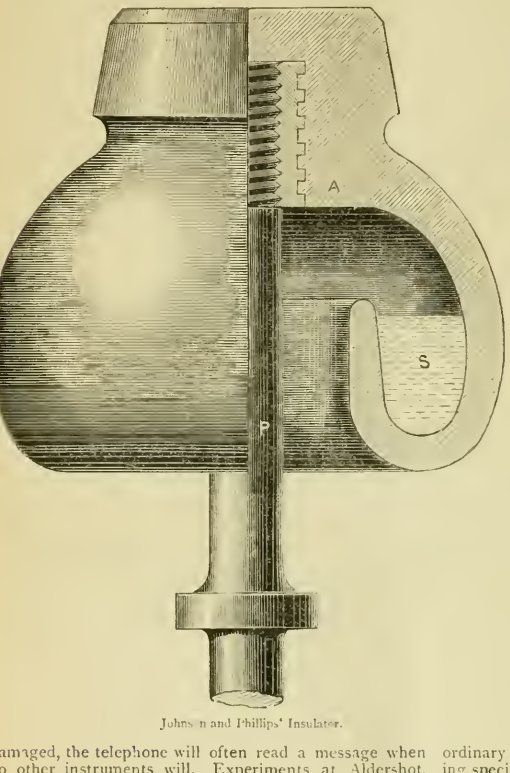
On August 5, 1816, the British Admiralty expressed their opinion to Sir Francis Ronalds that "telegraphs of any kind were then wholly unnecessary," and the invention of Ronalds was neglected. Nevertheless, being worked by static electricity, it is doubtful if it ever would have become a practical success. The "fossil" telegraph of Messrs. Cooke and Wheatstone, laid between Euston and Camden Town in 1837, was the first practical telegraph in operation, and a specimen of it is shown by the Post Office. The line was formed of copper wires covered with cotton and pitch, and inlaid in triangular lengths of wood, which were buried underground. It was worked in connection with Cooke and Wheatstone's Five Needle Telegraph, the parent of the present single and double needle instruments, now used in railway signalling.

Especially interesting also are the porcelain tubes employed by Samuel Morse as insulators, and the lead type, cast by that inventor as early as December, 1832, for his electromagnetic telegraph, now known as the Morse inker. The original Cooke and Wheatstone needle instruments, and the apparatus designed to compete with them, for example, Alexander Bain's I. and V. telegraph, in which the alphabet is formed by the movement of two pointers attached to circular magnets moving inside coils; the Highton gold leaf telegraph, in which a strip of gold leaf inclosed in a glass tube traverses the field of a permanent magnet, and forms part of the line-circuit. When a current passes through the leaf it moves to right or left, according to the polarity. Henley's Magneto Telegraph, the Wheatstone A B C instrument, and the Bell receiver of Sir Charles Bright, are also shown. This last appeals to the ear rather than the eye, by striking two bells of different pitch, and is the forerunner of the modern class of "sounders" which are superseding writing telegraphs on land-lines in America and England, owing to their clean and rapid working, and the ease with which a clerk can listen to the message and write it down at the same time.

Space would fail us if we were to refer to all the historical apparatus exhibited by the Post Office. There the visitor will be able to trace the development of the electric telegraph in this country from the earliest attempts, and on the same table he will see at work the latest improved apparatus for transmitting and receiving messages. The Wheatstone automatic instrument, which is capable of sending 200 words per minute, and is chiefly used for press intelligence, the American duplex, on the Morse system, and the Pneumatic Despatch, for forwarding written telegrams from St. Martins le Grand to local stations in the City, are all in operation.

Before leaving the Post Office stall we ought to mention an imported curiosity, which excited a great deal of interest when first displayed in the Norwegian Section of the recent Paris Electrical Exhibition, and to which we drew attention some months ago. This is a sample of a telegraph post from Norway, which has been pierced through and through by the beaks of the black and green Norwegian woodpeckers. Two of these marauders are stuffed and mounted on the perforated pole which is the witness to their strength of beak and perseverance. The explanation of the singular attack is that the birds, hearing the vibration of the wires as they tremble in the wind, mistake it for the hum of insects within the post, and courageously peck their way into the coveted feast. It matters not whether the timber is fresh or old; and I have been assured by a Norwegian telegraph engineer, that he has found several newly erected posts perforated in a single night. Bears in the mountain districts are also said to attack the foot of the posts, tooth and nail, under the impression that there are bees within; and after the experiments of Mr. C. V. Boys on the influence of tuning forks on spiders (see NATURE, vol. xxiii. p. 149), the deception of these animals is quite intelligible The authenticated fact that wolves are scared away from whole districts in Norway on the appearance of a telegraph line there, is not so easily understood, unless it be that the wires are held to be some kind of snare. This explanation is supported by the custom of Norwegian farmers of running a cord on poles round their homesteads to keep off the wolves, and it is stated that an entire peninsula was kept clear of wolves by spanning its neck in this fashion.

The War Office exhibit, which, in the face of flattering expectations, and in spite of interested accounts, must be pronounced a very disappointing one, and comparatively insignificant when contrasted with the display made by foreign governments in Paris, has nevertheless a novel feature in the equipment of a mountain telegraph train for service in the field. This is carried by three dummy mules, one of which bears two drums containing about three miles of insulated wire for laying on the ground, another bears the working tools, and a third the sheltertent, furniture, and apparatus, constituting the mountain of fire. "Sounders" are used in preference to "inkers" as receiving instruments, and telephones are added, because when a wire is cut by the enemy, or otherwise damaged, the telephone will often read a message when no other instruments will. Experiments at Aldershot, and recent experiences in Caffraria, have proved that a telephonic message can be received, though the wire is cut and lying on the ground. As an aid to military telegraphy in a difficult country possessing a brilliant sun, the War Office also exhibit a Mance heliograph, or adjustible mirror, for flashing a beam of light in signals, according to the Morse telegraphic code. The great advantage of this apparatus is that there is no wire which can be cut by the enemy, and little or no delay in erecting a sending-station. In the recent campaigns of Afghanistan and Zululand it has proved of great service to the army, and messages have been flashed over distances varying from forty to sixty miles.



Johnson and Phillips' Insulator.

Railway signalling from its earliest infancy is admirably illustrated by the stall of the South-Eastern Railway Company, whose engineer, Mr. C. V. Walker, F.R.S., was one of the first to see the importance of the telegraph for the prevention of accidents and the furtherance of traffic. Mr. Walker's original electromagnetic semaphore, now used in block signalling, his plan for intercommunication between passengers and guards, and his train-describer for announcing to the next station the character of the approaching train, are all worthy of close attention. Mr. Spagnoletti's apparatus, as used on the Great Western Railway, including his indicator for showing if a lamp is "in" or "out," is also very interesting. So, too, is the new system of Messrs. E. K. Winter and Craik, for working single lines on the block system, and now employed with great success in India. By this arrangement, a train leaving station A for station B itself puts the outdoor signal at A to danger, and this signal remains unalterable by either signalman of himself, until the arrival of the train has been signalled from B to A, and "line clear" has again been asked for and obtained. Models of the Preece system, as worked on the London and South-Western Railway, the Sykes' combined lock and block system, as used on the Metropolitan District, and other railways, and Harper's interlocking instruments, as employed by the London, Brighton, and South Coast, and other Railways, are also exhibited. This company likewise shows the Saxby and Farmer Union of Lock and Block Signalling, and many other things, including Perry and Houghton's alarm for tunnels, together with alarm-bells for gatehouses or level crossings. The electric fog and night signal of Mr. E. A. Sullivan is worthy of note. By this the wheel-tire of a passing train is made to press down a lever and sound a gong, but the gong can only be sounded when the signalman liberates the lever by electromagnetism. In King's Electric Railway Signal (exhibited by the Electric Railway Signalling Company of Stone Cross, Notts), there are signal posts placed at intervals along the line, and the train passing the first of these puts the signal, by mechanical means, at danger, while at the same time it signals forward by means of electricity to any distant junction. On passing the next post, it puts the signal at danger, and sets the post just past at line clear. At junctions the signals are connected with the points, which, when opened, show danger to the driver coming on the main line, and clear to the branch, remaining so until the points are closed.

The English firm of Siemens Brothers, Charlton, exhibit a number of portable field outpost telegraphs, with sounders and inkers, such as are used in the German army. Jointers' tools, A B C instruments, and other ordinary telegraphic apparatus, is also displayed, including specimens of their compound telegraph wire, made by covering steel wire with a skin of copper, to increase the electric conductivity and non-rusting qualities. Siemens' telegraph poles made of wrought-iron tubes inserted into cast-iron tubular bases, are also exhibited, together with Le Grand and Sutcliffe's base pile for sinking into the ground, to form a root for the pole. The great weight of this pole is, however, against it, for use abroad, where, owing to the ravages of the white ant, iron poles are preferable to wooden ones. Weight is an important item when transport has to be considered in a new country, and hence the lighter pole of Mr. J. Muirhead (as exhibited by Messrs. Latimer, Clark, Muirhead, and Co.) has advantages in this respect. It consists of a light iron tube, strengthened below by a steel lining, and inserted

in a cast-iron socket, which is flanged vertically to give great strength combined with lightness. The cast-iron socket has a small, flat base plate, which enters the ground, but the lateral resistance of the pole is chiefly due to the radial position of the vertical flanges, which press upon an ever-increasing section of the surrounding soil. Messrs. Latimer, Clark, Muirhead, and Co. exhibit a great variety of telegraphic apparatus, part made by themselves, and part by the Western Electric Manufacturing Company of Chicago. Certain of the American sounders are models of neat workmanship and compact device. While upon the subject of sounders, which are the most promising of telegraphic receivers at present, we may mention the bell-sounder of Sir Charles Bright, exhibited on the stall of Mr. E. B. Bright, C.E. The hammer of this ingenious little instrument strikes upon two musical brass tubes of different pitch, and so gives out a much pleasanter sound than the tapping of the ordinary sounder.

The number of wire and cable manufacturers who exhibit at the Crystal Palace is considerable, and there are signs of great activity in this department, especially for telephonic and electric lighting purposes. We have only to deal with land lines at present, and may mention the excellent specimen of galvanised iron telegraph wire exhibited by Messrs. Johnson and nephew, and Mr. Walter T. Glover, of Manchester, and others. The chief novelty in land wires is the use of phosphor bronze for telephonic lines. This alloy is very strong and conductive, so that much smaller wires are required than when iron is used. Moreover, it withstands the chemical action of atmosphere better, and is less exposed to storms. Its use, however, has not become at all general; and this is partly due to its great elasticity, rendering it difficult to put up. Specimens of this wire are shown by the Phosphor Bronze Company, of Sumner Street, London.

In insulators the pattern exhibited by Messrs. Johnson and Phillips is deserving of notice. As illustrated in the figure, it consists of a porcelain bell A, curved inwards to form an oil-well S, which is filled with a fluid insulator, such as paraffin. P is the bolt of the insulator, which supports it from the bracket of the pole. As a film of dew or rain cannot form on the surface of the insulating oil, the insulation resistance of this insulator is said to be many hundred times higher than that given by the ordinary insulators in use, and what is perhaps of more consequence, it is far more constant.

The tendency of the time is for overhead telegraph wires to give place to underground ones, as they have in Germany. Underground wires are less subject to accident from violence or storms, and hence are easily maintained in good condition. Trunk subterranean lines are about to be laid in England by the Post Office, and there are signs that the existing telephone lines will ere long have to be superseded by wires laid under the streets. For this purpose the box curb of Mr. W. Reddall, exhibited in the Western Gallery, may be useful. The idea is to make the curb of the pavement in the form of an iron box in proper lengths, and lay the wires in it; the lid being removable at will for inspection. The strong earthenware jointed pipes made by Messrs. Doulton and Co., of Lambeth, for holding subterranean wires, are also worthy of remark.

NOTES

PROF. E. RAY LANKESTER, F.R.S., has been appointed to the Chair of Natural History in the University of Edinburgh, in succession to the late Sir C. Wyville Thomson.

THE Senatus Academicus of Edinburgh University have resolved to offer the honorary degree of Doctor of Laws to Mr. John Simon, F.R.S., late medical adviser to the Privy Council; Dr. Angus Smith, F.R.S.; and Mr. Joseph Anderson, secretary to the Society of Antiquaries, Edinburgh. The degrees will be conferred with the ordinary examination degrees in arts, sciences, and divinity at the graduation ceremonial to be held on April 21.

THE President of the Linnean Society, Sir John Lubbock, held a reception at the Society's rooms at Burlington House on Tuesday last. The guests began to arrive at nine o'clock, and were received in the Library by the president and officers. Prominent amongst the objects exhibited was a striking portrait of Mr. Charles Darwin, painted for the Society by Mr. John Collier, and allowed by all to be the best portrait extant of our great naturalist. Carnivorous plants were strongly represented amongst the large contributions of plants from the Royal Gardens, Kew, and the leading nurserymen; in addition there were many fine specimens shown for their ornamental qualities. In the glass cases of the Library there were exhibited manuscripts of Linnæus, and medals struck in his honour; Wedgwood medallions of scientific men (lent by Sir Joseph Hooker); a series of caddis-flies, shown by Mr. R. MacLachlin; dredging apparatus, &c., by Mr. H. C. Sorby; new drugs by Mr. Thomas Christy; and Sikkim Rhododendrons, by Mr. J. H. Mangles. In the galleries was placed a series of cases of crustacea and insects, exhibited by Mr. J. T. Carrington; and in the Council Room a set of drawings of pollen, made by Mr. Charles White. The rooms were well filled during the evening, and among the visitors were many men distinguished in various departments of science.

THE following are the lecture arrangements of the Royal Institution after Easter:—Mr. E. B. Tylor, four lectures on the History of Customs and Beliefs, on Tuesdays, April 18 to May 9; Prof. A. Gamgee, four lectures on Digestion, on Tuesdays, May 16 to June 6; Prof. Dewar, eight lectures on the Chemical and Physical Properties of the Metals, on Thursdays, April 20 to June 8; Mr. F. Pollock, four lectures on the History of the Science of Politics, on Saturdays, April 22 to May 13; and Prof. D. Masson, on Poetry and its Literary Forms, on Saturdays, May 30 to June 10. The Friday evening meetings will be resumed on April 21, when Prof. Dewar will give a discourse on the Experimental Researches of Henri Ste Claire Deville.

THE following are among the papers announced to be read at the meeting of the Institution of Naval Architects to day and to-morrow:—The revision of the tonnage laws, by W. H. White; on tonnage measurement and moulded depth in relation to freeboard, by W. W. Rundell; on the basis for fixing suitable load lines for mercantile steamers and sailing vessels, by B. Martell; on launching velocities, by W. Denny, F.R.S.E.; on the transverse strains of iron merchant vessels, by Messrs. P. Jenkins and T. C. Read; on progressive speed trials, by J. H. Biles; on curves of stability of some mail steamers, by J. H. Biles; approximate formulæ for the calculation of trim, by M. J. A. Normand; on the reduction of transverse and longitudinal metacentric curves to ratio curves, by W. Denny, F.R.S.E.

ON Tuesday evening, at the Royal College of Physicians, a large representative meeting of both branches of the medical profession was held, with a view, in face of organised opposition to the progress of scientific research, of taking steps to "bring the legitimate influence of the medical profession more effectively to bear on the promotion of those exact researches in physiology, pathology, and therapeutics which are essential to sound progress in the healing art." Sir William Jenner presided. The chairman pointed to the fact that at the present time there was no society to guide and protect research, and stated that it was intended to found the proposed society on a broad basis. He declared that it was not proposed to attempt to abrogate the existing law on research; but it was intended to watch the operation of the law, and to see that there were no delays in important cases. He referred, as an instance of the

dangerous delays which occurred in granting licenses to the late poisoning case tried at the Old Bailey. The society proposed to be formed could, on the one hand, will bring its influence to bear to restrain those ardent pursuers of science who did not regard the susceptibilities of the public, and, on the other, it could enlighten the public, and so lessen the morbid sensibilities which had been aroused. He then proposed that the society should be formed; the motion was supported by the Master of the Rolls, who wished "God speed" to those engaged in research for the alleviation of human suffering. The motion was carried *nem. con.* The president of the Royal Society, Mr. Spottiswoode, seconded by Dr. Quain, proposed that the association should be formed of representative members of the profession and others, and this was carried. Sir James Paget, Sir William Gull, Sir Risdon Bennett, Sir J. Lubbock, and others proposed and supported resolutions on matters of detail.

It is probable that the Observatory of Popalar Astronomy established by a decree of M. Paul Bert in the Trocadero Palace, Paris, will be transferred into a general institute for popular education. The appointments gazetted by M. Paul Bert on the very day on which he left the Ministry will be declared void, and other appointments are to take place to meet the requirements of the enlarged institution. Since he resigned his seat in the Cabinet, M. Barthelemy St. Hilaire has resumed his great work of translating Aristotle. Up to the time of his appointment twenty-four volumes had been published by him. The matter in hand will fill not less than twenty-six volumes, and is mostly confined to the natural history. Two volumes on the Habits of Animals will be published before the end of the year, and the others are to follow in quick succession. The last volumes will be devoted to Problemata and Fragmenta. A copious index will be the crowning part of this magnificent publication.

At the meeting of the Royal Dublin Society, held on the 20th inst., Prof. Hull, F.R.S., laid before the "Natural Science Section" a series of 28 maps of the British Isles and the adjoining parts of the European continent, to which he has given the name of Palæo-geological and Geographical Maps. With the exception of the last three of the series, the maps are in duplicate. On one is represented by colour the position of each geological formation (or group of formations), and by a lighter shade of the same colour is shown the area under which this formation is considered to extend beneath more recent strata. On the corresponding duplicate an attempt is made to restore the "palæo-geography" of the period represented by the formation in question—the land being represented by shades of brown, the sea by those of blue, according to the heights in one case, and the depths in the other. The formations treated in this manner are: 1, the Laurentian; 2, the Cambrian; 3, the Lower Silurian; 4, the Upper Silurian and Devono-Silurian (or Lower Old Red Sandstone); 5, the Devonian; 6, the Old Red Sandstone and Lower Carboniferous; 7, the Upper Carboniferous; 8, the Permian; 9, the Trias; 10, the Lias and Oolite (Jurassic); 11, the Cretaceous; 12, the Tertiary (Eocene and Miocene); 13, the Post-Pliocene or Glacial, in three maps. The above grouping was found to be the most convenient for representation, and the colours used for the formations are those of the Geological Survey. Some very interesting results are brought out respecting the physiography of past geological times, including the probable position of the old continent of Atlantis, which the author considers to have existed in Laurentian, Cambrian, and Lower Silurian epochs. The recent borings for coal, or water, under the Cretaceous and other strata of the south and centre of England, have enabled the author to show with much precision the structure of these districts; and he places a possible coal-basin under the margin of the North Downs and the Wealden area, thus agreeing with the views long since stated by Mr. Godwin-Austen.

Vienna is to have its Exhibition of Electricity in the coming autumn. A committee has been formed, under the presidency of Count Hans Wilczek. The Board of Trade has offered the committee every support.

Col. Burnaby made a successful balloon trip across the Channel on Thursday last. He was alone, and had a large load of ballast, by judicious expenditure of which he was able to avail himself of favourable air-currents. He left Dover at 10.35 a.m., and came to ground about eighteen miles beyond Dieppe late in the afternoon. His greatest altitude seems to have been 11,000 feet.

A recent number of the *Celestial Empire*, referring to a discovery of some ancient graves near Shanghai, gives an interesting account of Chinese burial in former times. A man of means purchased his coffin when he reached the age of forty. He would then have it painted three times every year with a species of varnish, mixed with pulverised porcelain—a composition which resembled a silicate paint or enamel. The process by which this varnish was made has now been lost to the Chinese. Each coating of this paint was of some thickness, and when dried had a metallic firmness resembling enamel. Frequent coats of this, if the owner lived long, caused the coffin to assume the appearance of a sarcophagus, with a foot or more in thickness of this hard, stone-like shell. After death the veins and the cavities of the stomach were filled with quicksilver for the purpose of preserving the body. A piece of jade would then be placed in each nostril and ear, and in one hand, while a piece of bar silver would be placed in the other hand. The body thus prepared was placed on a layer of mercury within the coffin; the latter was sealed, and the whole then committed to its last resting-place. When some of these sarcophagi were opened after the lapse of centuries, the bodies were found in a wonderful state of preservation; but they crumbled to dust on exposure to the air. The writer well observes that the employment of mercury by the Chinese of past dynasties for the purpose of preserving bodies ought to form an interesting subject for consideration and discussion in connection with the history of embalming and "mummy making."

The return of works licensed to be printed during the past two years by the Japanese Department of the Interior is of much interest as showing the tendency of the minds of educated people of the country. The figures show that considerable mental activity exists in the country. Last year 545 works on political subjects were issued, against 281 the previous year. Law was represented by 255 works against 207 in 1880; while in political economy the numbers were 25 and 15 respectively. Geographical works declined from 170 in 1880 to 164 in 1881; while in medicine the increase was from 229 to 267. In scientific subjects we find 25 works on chemistry, and 22 on natural history in 1880, reduced 17 and 20 respectively in 1881. Natural philosophy also shows a decline from 19 to 13; so do mathematics from 116 to 107. Similarly works on astronomy have declined from 9 in 1880 to 7 in 1881. In other classes of books, however, we find a great increase. Ethical and moral works have increased from 32 to 93; historical works from 196 to 276; books on poetry and poetical works from 491 to 556; books on drawing and writing from 127 to 339. Engineering works have increased from 8 to 28; and books on commerce from 70 to 113. School-books again this year are nearly half as numerous as all other books put together, numbering 704 against 707 last year. Lighter literature is by no means neglected, for 193 volumes of tales, novels, &c., were published during 1881. During the year 149 new newspapers started, but the large proportion of 114 never saw the commencement of the present year. In 1880 the publication of 266 new journals commenced, 47 of which soon succumbed. The operation of the press laws cannot be very stringent, when we find that during two years, of 415 newspapers,

161 of which ceased, only one was prohibited by the Government. In addition to those above-mentioned, we find in the list works on etiquette, accounts, naval and military works, dictionaries, encyclopædias, &c. The total number of works published during the year was 4910 against 3792 last year. Very many of these books are translations or adaptations of European or American works. Among such books recently "conveyed" we find Smiles's "Character," Roscoe's "Chemistry," Leone Levi's "International Commercial Law," Bouvier's "Law Dictionary," Palgrave's "Chairman's Handbook," Lord Chesterfield's "Letters," "Every Man his own Lawyer," Taylor's "Medical Jurisprudence," Thompson's "Social Science and National Economy," Baxter's "London Statistics," "The Science of Familiar Things," Mill's "Three Essays on Religion," Draper's "Conflict of Religion and Science," portions of Buckle's "History of Civilisation," Thompson's "Outline of the Necessary Laws of Thought," &c. As to the price of these works, we may instance Smiles's "Character," the translation of which by Nakamura, a well-known English scholar, in two volumes, costs only 50 *sen*, or about a shilling at the present rate of the paper currency. The figures and facts here recorded show at least that the path of western progress which the Government is pursuing, is one in which the people desire to take a part.

We have received from the President of the University of Tokio a copy of the calendar of that Institution for the past year. It is printed in Japanese and English, and thus appears somewhat more bulky than its actual contents would warrant. In the preface, a brief account is given of the growth of this large and apparently flourishing establishment from its first small commencement as a bureau for translating foreign books. We have heard so much recently of the changes in the *personnel* of the Japanese educational institutions from foreign to native teachers, that we turn with some interest to the list of professors. In the department of law we find one foreign and eight native teachers (including in this term professors, lecturers, instructors, &c.). This subject is exceptional, as there are five professors of Japanese law In science, of the twenty six teachers, eighteen are natives, and we believe this number has increased recently; and in literature three of the fourteen teachers are foreigners. Judging simply by the degrees which they have obtained in western universities, most of the Japanese gentlemen seem well qualified for their work. This great and rapid displacement of foreign instructors is certainly a delicate experiment, and we can only hope that it may be successful. *Chi va piano va sano* is a motto which may be commended to Japanese attention in this respect as in many others. The students can hardly complain of excessive charges. The tuition fee for each term (of which there are three in the year) is only four *yen*, nominally 16*s.*, but at the present rate of the currency rather less than 9*s.*; while the cost for a term of living, fire, light, &c., is only fourteen *yen*, or about 32*s*. The total number of students attending the college is 205. The examination papers, which are given in full, seem to be quite up to the standard for similar examinations in this country. We are glad to observe that Japanese literature and history are not neglected in the study of more western subjects. A large number of teachers have been provided for these subjects.

Prof. Civiale is preparing a large photographic work on the Alps. For ten years, from 1859 to 1868, the author travelled in the Alps with his camera, constantly taking panoramic and smaller (detailed) views. The latter, some 600 in number, principally show the glaciers with their crevasses, moraines, and the rocks forming their banks, the mountains, valleys, glens, natural geological sections, the rocky eminences groved, polished, or ground by former glaciers, and the course of various rivers. The panoramic views, forty-one in number, are taken from the summits, and comprise all the large Alpine chains. Each consists of a number of plates, and twenty include the whole circle of view. These valuable plates are accompanied by two maps in 1 : 600,000, one is specially orographical, the other shows the curves of the panoramic views. Thirteen years were necessary to put the material collected into proper order, to replace the photographic plates by printed ones, to draw and engrave the maps, and to write the text.

The recent remarkably low level of nearly all the Swiss lakes has encouraged the scientific circles of Switzerland to make fresh researches with regard to pile-dwellings. The societies of the Canton of Thurgau have investigated the Untersee (the lower part of the Lake of Constance), near Steckborn, in the vicinity of the former monastery of Feldkirch. The Untersee was surrounded by a complete circle of pile-dwellings, and the present investigations have yielded valuable results, in the shape of a long list of the most varied objects which have been brought to light.

The Russian Society of Painters has started a new publication, which will be of interest, not only for lovers of the Fine Arts, but also for science. It is a periodical, "Art in Central Asia," being a collection of well printed drawings of Central Asian architectural ornaments, carpets, paintings, and so on, published under the supervision of M. Simakoff and of the above named society.

We learn with pleasure that a special "Geological Committee" has been instituted in Russia, at the Department of Mines, for a systematic geological exploration of Russia, and for the preparation of a detailed geological map of the country. The Government has allowed an annual grant of 3000*l.* for the expenses of the Committee and for its publications.

Dr. Rae points out that, according to the Royal Geographical Society's *Journal*, the late Pundit Nain Singh was awarded not the Royal Medal, but a gold watch.

We have been requested to state that the late Dr. T. Romney Robinson was born in the year 1792, and not in 1793, as stated erroneously in the obituary notice which recently appeared in our columns.

The additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus radiatus* ♀ ♀) from India, presented respectively by Mr. Henry Worth and Mrs. Nicholson; three Herring Gulls (*Larus argentatus*), British, presented by Mr. Rowland Ward; a Herring Gull (*Larus argentatus*), British, presented by the Chevalier Da Costa Ricci; a Sclater's Curassow (*Crax sclateri* ♂), a King Vulture (*Gypagus papa*) from the Province of Alagoas, Brazil, presented by Mr. Frederick Youle; a Puffin (*Fratercula arctica*), British, presented by Mr. H. M. Upcher; two Grey Ichneumons (*Herpestes griseus* ♂ ♀) from India, two Tayras (*Galictis barbara*) from Brazil, a Wild Boar (*Sus scrofa*), European, deposited.

OUR ASTRONOMICAL COLUMN

The Great Comet of 1881.—In the *Monthly Notices* of the Royal Astronomical Society for January there are published two letters addressed to the secretaries by Dr. W. Bone of Castlemaine, Victoria, referring to an object seen near the great comet of last year, on the evening of June 10. In a telegram which he sent to the Melbourne Observatory the same night, he described it as discoid and like a circular comet, and states it had travelled south 6′ in thirty-four minutes; its place at 6h. 45m. in R.A. 5h. 18m 30s., Decl. − 14° 24′. He asked that search might be made at Melbourne, but mentions that his telegram was not answered. In his first letter he writes: "On June 10, 1881, whilst measuring the position of the comet, then visible here at 5h. 52m. mean time of place, I noticed a peculiar discordance in each succeeding measure, and at length found that the star (?) from which I was measuring was a rapidly-moving body." He found it "somewhat discoid, but its light, although bright, was

diffused and hazy," and adds that it had moved through six minutes of arc in a *northerly* direction, contrary to what was stated in his telegram. The approximate place for 5h. 52m. mean time (as we take it) was in R.A. 5h. 18m. 8s., Decl. − 14° 18′, showing that a southerly motion was intended. In his second letter Dr. Bone says: "I should place the magnitude at about 2·5, for it was visible to the naked eye in first twilight;" though the telegram has what in this case was somewhat unnecessary information: "No asteroid in that place."

An observation of this kind would hardly perhaps have required strict examination, were it not that about thirty-eight hours later Dr. B. A. Gould, at Cordoba, compared the comet with an object which he could not afterwards identify, and after much hesitation, through fearing some great error, he communicated the particulars to the *Astronomische Nachrichten*, No. 2384. We have already referred to these observations in this column (NATURE, vol. xxiv. p. 342). At 10h. 58m. 9s. sidereal time, on June 11, Dr. Gould made a rough preliminary determination of the comet's place, for the purpose of finding a comparison-star, when he says he found one in the field; with this star he compared the comet four times, the results being:—

Cordoba Sidereal Time. h. m. s.	Comet followed. s.	Comet South. ′ ″
11 8 49	49	5 12·9
— 11 2·5	49	5 8·3
— 13 11 0	48	5 8·5
— 14 37·5	48·5	5 2·8

The rough place of the comet by the circles of the equatorial, agrees sufficiently well with that we now know it must have occupied at the time, but if the comet had been observed during the micrometrical comparisons, the position of the supposed star would have been 5h. 10m. 23s., Decl. −9° 29′·8, where no star has been catalogued, though Dr. Gould thought it would hardly be below the third magnitude, and he could rather believe it as bright as the second.

In *The Observatory* for January, Mr. Christie has printed a letter from the able amateur, Mr. John Tebbutt, of Windsor, New South Wales, suggesting an explanation of Dr. Gould's observation which merits attention. He made four circle-comparisons of the comet with Rigel on the morning of June 12, the last of which was only 1h. 29m. of absolute time previous to the first observation at Cordoba, and he states "there was then, I am confident, no object near the comet answering to the description already given." Were it not that the Cordoba instrumental place agreed closely with the actual position of the comet, he adds, he would be disposed to suggest that Dr. Gould had not observed the comet with the micrometer at all, but possibly the two stars, B.A.C. 1592 and 1597, "whose relative magnitudes and position agree almost exactly with his observations, and whose differential declination would gradually diminish from the effect of refraction as the stars approached the horizon."

We will now examine the case with some strictness. The following positions of the comet are calculated from the elements published by Mr. White, of the Melbourne Observatory, and will be very nearly correct for the dates in question:—

G.M.T.	True R.A. h. m. s.	True N.P.D. ° ′ ″	Log. distance from the Earth.
June 9·5	5 9 23·9	104 57 5	9·59144
10·0	5 9 50·5	103 39 30	9·58131
10·5	5 10 18·2	102 17 33	9·57121
11·0	5 10 46·9	100 51 6	9·56116
11·5	5 11 16·8	99 19 59	9·55121
12·0	5 11 48·2	97 44 2	9·54139

From the ephemeris, it follows that the comet's motion between Dr. Gould's first and last comparison was + 0s.·41 in R.A., and +44″·7 in declination. The observed difference in declination was only 10″·1. If Dr. Gould had observed the comet the difference of refractions of comet and star would have been about 0·28s. and 2″·6 at the first comparison, and 0·47s. and 4″·3 at the last, so that the discordance between observed and computed motion would not be explained by the refraction.

The stars referred to by Mr. Tebbutt are Bradley 718, and 69 λ Eridani, and both are found in Mr. Stone's recently published catalogue. Their apparent places on June 11 were:—

	R.A. h. m. s.	Decl. ° ′ ″
Br. 718	5 2 39·06	− 8 49 14·6
λ Eridani	5 3 27·90	− 8 54 27·8

If now, Dr. Gould, in "the exceptionally thick haze and mists of the horizon," and bright twilight which he mentions, mistook λ Eridani for the comet, and compared it with Bradley 718, we have the following striking agreement:—

	In R.A. s.	In Decl. ′ ″
Differences of above places	+48·8	− 5 13·2
By Gould's comparisons	+48·6	− 5 8·1

Difference of refractions at first comparison, 0·7s. and 6″·5, and at the last comparison, 1·7s. and 15″·7, so that the ten seconds' change in the difference of declination measured with the micrometer is accounted for by refraction, and there is a tendency to diminishing difference of R.A. in the comparisons, which refraction would necessitate. Dr. Gould states, that these comparisons were all he could obtain "before the comet passed below the horizon," and the true altitude of λ Eridani at the last of them was 2° 17′: the altitude of the comet at the same time being 4° 15′.

Mr. Tebbutt thinks, if his suggested explanation be accepted, it will be necessary to admit "a temporary outburst in the light" of B.A.C. 1592 (Bradley 718), and it happens that there is some reason for believing that star to be variable. It is a wide double star, No. 649 of the Dorpat catalogue. Sir John Herschel, in one of his sweeps at the Cape of Good Hope, on December 26, 1836, estimated the principal component 7·8 (the companion is about 10m.): it was rated 6·0 by Struve, 6·8 by Jacob in 1849, and 6 or 7 by Lalande, Bessel, Knorre (in his Berlin chart), Santini, and others, but in Mr. Stone's new catalogue it is called 5m., or only one magnitude less than λ Eridani, which has been pretty consistently estimated a fourth.

It appears, then, that Mr. Tebbutt's explanation of the difficulty in Dr. Gould's case, is a very probable one: the instrumental comparison preceded the first micrometical observation about ten minutes, and the assumption of course will be that after applying the micrometer, the telescope, instead of being pointed to the comet, was turned upon the stars alluded to above, which, in the dense haze, were blurred and confused.

With respect to the observations at Castlemaine, Victoria, on June 10, it is to be regretted that Dr. Bone has not communicated the comparisons of the comet with star as entered in his note-book, and his letters having been given publicity in the official periodical of the Royal Astronomical Society, it is desirable that these should be forwarded, that the true explanation may be found. His geographical position is given in a note on the last Transit of Mercury, which appears in the same number of the *Monthly Notices*: longitude 9h. 36m. 55s. E., latitude 37° 4′ 11″ S.; that phenomenon was observed with a 4·7 inch (Wray) equatoreal, which it may be presumed was the instrument used for observing the comet. It so happens that observations were made the same evening at the Melbourne Observatory, and the earlier comparisons at the same time that Dr. Bone was similarly employed at Castlemaine, which is only 3 min. west of Melbourne. The Melbourne reference star was at first 8 Leporis, the apparent place of which was in R.A. 5h. 8m. 4·2s., Decl. − 14° 2′ 25″, therefore in the same R.A., and only 15′ north of the position which Dr. Bone assigns to the moving object at 5h. 52m. M.T. It is difficult to explain how such an object could have escaped the attention of the Melbourne observers, while they were comparing the comet with a star so close to its place. The position of the real comet may be interpolated from the above ephemeris, or it may be inferred from the Melbourne observations the same evening. The second series of comparisons were made with a star which we find to be No. 173, Hour V. of Weisse's Bessel, and reducing this series we have for the comet's place:—

Melbourne M.T. h. m. s.	App. R.A. h. m. s.	App. Decl. ° ′ ″
June 10 at 6 3 13·6	5 9 40·83	− 14 3 22·1

Comparing this with the result of the earlier measures from 8 Leporis (*Monthly Notices*, vol. xli. p. 432), we have the following positions of the comet for Dr. Bone's times:—

h. m.	R.A. h. m. s.	Decl. ° ′ ″
At 5 52	5 9 40·5	− 14 4 15
6 45	5 9 42·7	− 13 58 32

At 5h. 52m. its true altitude was 8° 54′, but it set at 6h. 41m., four minutes before the last observation at Castlemaine. With Dr. Bone's place for his object it would be 1° above the horizon at this observation. Refraction would of course have been exercising a great effect upon any comparisons made near so

small an altitude. In the absence of the original observations, we can only conjecture that the supposed moving object or second comet, was none other than the Melbourne comparison star S Leporis (commonly estimated 6m.), and it may have been under this impression that Mr. Ellery did not think it necessary to reply to the telegram sent to him from Castlemaine. The motto of the Royal Astronomical Society, "*Quicquid nitet notandum*," upon the principle of which Dr. Bone says he acted in putting his observation upon record, is a good one no doubt, but where there is suspicion of error it is desirable to be in possession of all particulars, and in this view we would suggest the early publication of his comparisons as they were actually made.

A NEW COMET.—A comet discovered in America, apparently on March 18, is likely to become a conspicuous object before perihelion, which, according to the first rough orbits, does not take place until June.

MEDICAL ELECTRICITY

A PAPER "On Measurement in the Medical Application of Electricity," was read before the Society of Telegraph Engineers, by Dr. W. H. Stone and Dr. Walter Kilner, on March 9. Dr. Stone commenced by stating that the subject had been suggested by Lieutenant-Colonel Webber, the chairman, and that the details the authors proposed to give that evening were mainly preliminary to fuller treatment, which they hoped to offer at some future period.

Medical electricity, he said, had been up to now a heterogeneous mixture of loose statements, doubtful diagnosis, and erroneous therapeutics. Glaring instances of these were given. With hysteria, Metallotherapy, and magnetic appliances, they did not propose to deal: science is in far too elementary a state to see through these obscure, though real phenomena. Probably, the key to the great enigma of the connection between electricity and nerve force had yet to be found. The bold statement that "electricity is life" is demonstrably false in many particulars. Speaking generally, medical electricity had suffered from its exclusive handling by physiologists and physicians, who might receive valuable help from physicists; indeed, the writers of the paper were actually soliciting such assistance at the hands of this young and active society. Medicine and its kindred arts lend themselves ill to measurement: the tone of mind required for their practice is rather judicial than computative; it is oftener concerned with weighing evidence, and balancing alternatives, than with solving equations. But men who work by measurement are usually sterling and accurate men; indeed, Prof. Schuster has recently shown how mathematics can help science. Where measurement *can* be used, it *should* be used; and this was their text for the evening.

The speaker then proceeded to divide the forms in which electricity had been used medically into four, namely—(1) continuous currents, (2) continuous currents made to intermit, (3) induced currents, termed generally "Faradisation," (4) statical electricity. The last of these was the first employed, but it had given the least satisfactory results of any. The third method had been far the most deeply studied. Duchenne's great work on Localised Electrisation early drew attention to this department. That genuine and indefatigable observer was able to point out so many definite diagnoses, and to isolate so many new nervous and muscular diseases by means of the induction-coil, that this instrument had been given somewhat excessive prominence as a therapeutic agent. Physiologists had also found in it a convenient stimulant for testing the action of nerves and the irritability of muscle; perhaps also the localisation of brain-functions. Hence muscular contraction and the action of intermittent currents in alternate directions had been too much relied on as evidence of activity. One chief object of the paper was to point out that the future of electro-therapeutics lies more in the continuous current, used either in its first or second form, the latter of which has hitherto received little or no attention. In confirmation of these views, extracts were read from Prof. Erb's valuable memoirs in Ziemssen's Cyclopœdia of Medicine.

Before, however, a single step could be taken in this scientific path, we must have some tolerably accurate mode of measuring the agent we are employing. It is obvious that the units used should be as far as possible those generally adopted in the scientific world.

To begin with resistance: This in the human body is singularly great, and is especially located in the epidermis, which, when dry, is an excellent insulator. Wetting it wtth sulphate of zinc or common salt diminishes this resistance very materially; though even when care is taken in this respect, the residual opposition to a current is large. From hand to hand it is usually about 6000 ohms. In the larger bulk of the trunk, from the sacrum to the nape of the neck, it never, even after long wetting, sinks much under 1500 ohms. That of the head, from nape to forehead, is about 2000 ohms. In one case it was more precisely 1930 ohms, in an adult, and in another, a child, 2500 ohms. The resistance of different tissues, though not exactly to the present purpose, had been studied by Prof. Eckhard, who stated that muscle was the best conductor, and that this being taken as a unit, cartilage would have a resistance twice, tendons and nerves about 2·1, and bone nineteen times as great. Matteuci states that muscles conduct four times as well as nerves, brain, or spinal chord. The resistance of the skin varies from day to day, being modified by moisture, and by the fulness of the capillary vessels. In a particular case, the positive pole of a battery was placed on the sacrum of a child, and the other on the leg, over the extensors of the foot. By using the same current, and adding quickly a known resistance, the resistance of the body was at first found to be 11,250 ohms, which, on thoroughly soaking the skin, was reduced 2875 ohms. Three days previously, the resistance before soaking was 13,000 ohms, and after that process sank to 3000 ohms. Personal idiosyncracy exercises an influence, a delicate skin conducting better than one which is coarse. The face and neck offer the least; the soles and palms the greatest resistance. Disease causes variation of conductivity: the skin over affected muscles in lead paralysis has its resistance increased, while in many old cases of hemiplegia it is decreased to a greater or less extent according to the amount of atrophy which has taken place.

The resistance of muscle in disease is sometimes diminished, sometimes augmented. Augmentation takes place, at the commencement of degenerative changes, from the inferior conductive power of fat to that of healthy muscle. In a case of infantile paralysis, the sound leg had a resistance of 2500 ohms, the affected leg of 3250 ohms. In a wasted muscle of many years' standing, the enormous resistance of 16,500 ohms was reached. It was both easy and desirable to multiply facts such as these.

The second preliminary point was the current which could be borne with impunity. Here results were very discordant. In the three fatal cases from touching the conductors of dynamo-machines, at a music-hall, in the Russian Navy, and at Hatfield, the necessary facts for measurement were absent; although Dr. Siemens had stated that he had often taken a current sufficient to produce a powerful light with impunity. In a case now in St. Thomas's Hospital, a current of 50 milliwebers was borne with difficulty, and one of 20 milliwebers with ease and great benefit. A case of diabetes, recorded by Dr. Stone in the *Proceedings* of the British Association at York in 1881, took about 10,000 micro-ampères, or 10 milliwebers, through his head, from nape to forehead, after some practice; using for its production from 15 to 20 cells of a bichromate battery. The particular battery, however, mattered very little; Leclanché's, bichromates and zinc-carbons with sulphate of mercury, all act well, and need not be of large size or small resistance. One was shown, in which test-tubes filled with mercuric sulphate, containing free acid, formed the jars; another in which a rod of zinc of 5·16″ diameter, and a similar sized carbon, such as is used in electric lamps, were immersed in the bichromate solution. Connection was here made with the carbon by a piece of drawn tube sprung on to it, thus doing away with the use of clamps. All these, as well as most of the apparatus shown, were made in Dr. Stone's workshop, chiefly with his own hands.

In consequence of the high resistance of the skin, it was essential to give a large size to the poles employed for applying the current, &c. Amalgamated zinc, with the mixture of potter's clay kneaded with the solution of common salt, used in physiological experiments, laid over it, was perhaps, theoretically, the best; but powdered carbon placed in a bag and immersed in salt and water, answered equally well; or the surgical appliance termed Spongio-piline, a thick felt, backed by india-rubber, through which a well-tinned copper wire was threaded, so as to encompass its whole circumference without anywhere projecting so as to touch the cuticle. The poles could hardly be too large.

A convenient form of Thomson galvanometer with graduated shunts, due to Dr. Kilner, was shown, and also a simple but effective instrument for producing intermissions in the current at any required interval of time. This apparatus consisted of a

metronome with contact-pieces dipping into mercury-cups at each oscillation, a condenser being placed under the instrument to get rid of the extra current, and so to equalise the physiological effect of the making and breaking currents.

The measurement of induced currents presented considerable difficulties. The Conference at Paris had recommended the use of standard induction-coils, but this method does not give any but arbitrary measures. Dr. Stone had tried and showed a vacuum-tube, in which the tension of air could be varied by combining it with a barometric-column and a movable cistern. This gave a ready means of varying the force af the discharge, by using it as a shunt of variable resistance, and had the interesting results of shunting the "make-current" at a definite point, while allowing the "break-current," which is about six times stronger, to pass between the platinum points; thus obtaining an induced current in one direction only. Latterly he had adopted also condensers of definite capacity charged to definite potentials. The writers were, however, still experimenting with another method, depending on Sir W. Thomson's determinations of spark-length. The most practical method, at present, seemed to be to pass a continuous current of measured strength through an automatic commutator, which at alternate oscillations diverted it in one and the other direction. If there was any real physiological value in rapid reversals of direction, as was claimed by some experimenters, it could thus be secured, without the use of an induction coil. Another form of rotating-commutator was also shown, in which an ebonite cylinder, pressed on by six springs, at each quarter-turn connected, first, the condenser to the battery, so as to charge it, and then discharged it through the patient. To obviate the necessity of employing a large battery with the condenser arrangements, Planté's secondary battery could be charged in parallel position from a small number of Grove's cells, and discharged through the condenser in series. In all these contrivances, however, as the current gained in tension, it seemed to lose somewhat in chemical and catalytic power, and to assimilate gradually to the static form.

In the discussion which followed Mr. Preece pointed out that the use of electricity for curative purposes had been advocated as long ago as the year 1759, by John Wesley, and recommended the use of the dynamometer for the measurement of induced currents, as this instrument gave indications in the same direction with all currents. Prof. McLeod, Mr. Fitzgerald, and Prof. Ayrton also made comments on the paper.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—It is proposed to spend 300*l*. extra within the next three years for the following objects at the Botanic Gardens: thinning the belt and groups of trees; raising the level of some unoccupied areas and sowing them with grass; replanting the willow bed and making new beds; and the improvement of the collection of trees, already good, so as to keep up its special reputation.

Prof. Hughes having expressed to the Vice-Chancellor the serious difficulty found in carrying on practical studies in the Woodwardian Museum without additional class-room accommodation, it is arranged that Mr. Keeping, the curator, shall cease to reside in the museum, and be allowed an equivalent sum for house-rent and other advantages attached to the curatorship.

Prof. Humphry proposes to take classes in Surgery during the Long Vacation.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, January.—A new odontograph, by H. Bilgram.—Dimensions and performance of the hull and machinery of the U.S. steamer *Dispatch*, by chief-engineer Isherwood.—Mechanical drawing, by C. Sellers, jun.—The application of frictional electricity to the purification of middlings, by R. Grimshaw.—On the constants in Gordon's formula for the strength of columns, by M. Merriman.—Chronological table of American patents, by E. Hiltebrand.

Annalen der Physik und Chemie, No. 2.—On the elliptical polarisation of light in reflection at crystal surfaces, by E. Schenck.—Influence of mechanical hardness on the magnetic properties of steel and iron, by L. M. Cheesman.—On the maximum of magnetisation of diamagnetic and weakly-paramagnetic bodies, by H. W. Eaton.—On the reflection of electric rays; the influence of the cathode's form on the distribution of the phosphorescent light in Geissler-tubes; the connection between density of gas and layer-interval in Geissler-tubes; and the band-spectrum of air, all by E. Goldstein.—On the formation of peroxide of hydrogen during combustion, by A. Schudler.—Reply with regard to the formation-heat of water, by the same.—The expansion of water through absorption of gases, by K. Ångstrom.—Theory of refraction on a geometrical basis, by A. Kerber.—On the minimum of rotation of the light-ray in combined refraction and reflection at a sphere, by F. Kessler.—The minimum of deflection of a light-ray by a prism, and the minimum of time in refraction of light, by the same.—On electric shadows, by P. Riess.

Archives des Sciences Physiques et Naturelles, February 15.—A hypothesis on the origin of species, by M. Thury.—Determination of the quantity of organic substances contained in waters of the Rhône, by MM. Graebe and Guye.—Dry plants found in mummies, by Dr. Schweinfurth.—Study on the chemical composition of albuminoid substances (continued), by M. Danilewsky.—Swiss geological review for 1881, by M. Favre.

Journal de Physique, February.—Thermodynamic acceleration of the earth's motion of rotation, by Sir W. Thomson.—Imitation of the forces acting in a dielectric, by M. Elie.—Electric lighting, by M. Foussereau.—Projection of the focus of the prism, by M. Crova.—On a phenomenon of physiological optics, by MM. Macé de Lepinay and Nicati.

Natura, February.—On the origin of metamera, by G. Cattaneo.—On the origin of electricity of thunder-clouds (continued) by F. G. Nachs.—Some notes on radiophony, by E. Mirabelli.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti, vol. xv. fasc. 1.—*Résumé* of meteorological observations at Milan, in the Brera Observatory, by P. Frisiani.—On linear systems, by E. Bertini.

Fasc. 2.—New indicator, at a distance, of the temperature of an inclosure, by R. Ferrini.—On two nummulitic deposits in the Pavian Apennines, by E. T. Taramelli.—Phosphates and wheat, by G. Cantoni.—On the theory of the diatomic scale, by E. Beltiami.—The double quadratic transformation of space and its application to non-Euclidean geometry of space (continued), by C. F. Aschieri.—Results of observations during 1881 at the Brera Observatory, on the diurnal excursions of the magnetic needle, by E. G. Schiaparelli.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, March 16.—Sir John Lubbock, Bart., M.P., F.R.S., president, in the chair.—Messrs. H. M. Brewer, V. I. Chamberlain, and A. P. Withiel Thomas were elected Fellows of the Society.—Mr. J. Worthington Smith called attention to certain very destructive Australian fungi new to England, viz. *Capnodium australe*, fatal to conifers, especially *Thuyas* and *Isaria fuciformis*, a great pest to grass in Kent and Sussex. The latter plant is popularly supposed to induce a disease similar to diphtheria, and said to be fatal to cattle. *Isaria* frequently grows on animal substances, dead and living, as on larvæ and pupæ of ichneumons, spiders, moths, wasps, &c.—Mr. Smith showed a bee caught alive in this country, and having a profuse growth of the *Isaria*-condition of the *Cordiceps sphecocephala*, a West Indian form, the latter genus being closely allied to *Claviceps*, or Ergot.—Dr. Francis Day read a paper upon the Salmones found in the British Isles, remarking how great changes are occasioned by retaining any of them in unsuitable localities. He objected to the augmentation in number of the British forms of migratory trout, from three to seven, as made by Dr. Gunther, holding that we merely possess two. The Lochleven trout, which is in reality a marine form, acclimatized to fresh water, whereas the remainder are solely trout races of the common brook trout.—A most interesting fact was brought forward, viz. that Mr. Arthur, in New Zealand, having lately examined the trout which were introduced there in 1869 from ova originally obtained from the Thames and the west of England, found great structural changes had taken place. The fish in question, moreover, living in different streams in New Zealand had also assumed local peculiarities of size and change of form; and, doubtless due to increased food, the annual

increment of weight had risen from $1\frac{1}{2}$ to $2\frac{1}{2}$ pounds, and an example had been seen weighing 20 pounds. The cœcal appendages hitherto held as significant of species were found augmented from 33 to 50, as exemplified in British fish, to from 43 to 54 in the New Zealand examples, therefore showing that these organs are inconstant as to number. Having alluded to the different species, Dr. Day concluded that, as the various species of non-migratory trout, accepted by Dr. Günther, interbreed, and the results classed hybrids are not sterile, such gives increased reason for supposing these various forms are local races, and not different species; that if they are really distinct species division has not proceeded sufficiently far, because the Gillaroo, or form of trout with a thickened middle coat of the stomach, has been termed *Salmo stomachicus*, Günther, whereas the great lake trout with a thickened stomach, and the Charr having a similarly transformed organ, have not yet been differentiated into species. Dr. Day considers that all our non-migratory freshwater trout (including the Loch Leven) are merely local races; that interbreeding will produce mongrels, in which sterility need not be anticipated, while introducing new races (unless in the principle of preventing breeding in and in) will not be of much benefit to fisheries, unless the food is in excess of local requirements, for if not the new-comers will revert to the colour, form, and size of the original tenants of the water.—Two papers by Mr. Charles Darwin—(1) on the action of carbonate of ammonia on the roots of certain plants; and (2) the influence of carbonate of ammonia on chlorophyll bodies were read, abstracts of which appeared in last week's NATURE.—The twelfth part of the Rev. A. Boog Watson's contributions to the mollusca of the *Challenger* Expedition was also read.

Geological Society, March 8.—J. W. Hulke, F.R.S., president, in the chair.—George Clementson Greenwell and John Baldry Redman were elected Fellows of the Society.—The following communications were read:—Additional note on certain inclusions in granite, by J. Arthur Phillips, F.R.S. The author referred to certain rounded inclusions in granite which were rich in mica. These he had described in his paper published in vol. xxxvi. of the *Quarterly Journal*, and had considered to be contemporaneous segregations from the molten rock. He had, up to that time, not found a case where one of the larger crystals of felspar in a porphyritic granite occurred partly in the one, partly in the other. Of late he had seen several, one of which he described minutely, thus proving the correctness of his supposition.—The geology of Madeira, by J. S. Gardner, F.G.S. Madeira consists almost wholly of sheets of basalt lava of variable thickness, interstratified with tuff scoria and red bole, cut by innumerable dykes. In the central part of the island is a horse-shoe-shaped valley, more than four miles in diameter, its bed 2500 feet above the sea, its precipitous walls full 3000 feet high, rising here and there to yet greater elevations, and forming a central point in the mountain system of the island. This the author regards as the basal wreck of a volcanic mountain, blown into the air by an explosion of exceptional violence. Fragments of the slopes of scoriæ, which once composed the inner shell, remain on the peaks surrounding this amphitheatre. The dykes here are trachyte. The author describes a limestone exposed in one place beneath the basalts, and referred to the Upper Miocene, and a plant-bearing bed associated with them, containing fossils of species still living in the islands, some of which have been wrongly referred to extinct forms. In conclusion, the author remarked upon the almost infinite variability of the genus *Robus*, and the difficulty of distinguishing its species. —On the crag shells of Aberdeenshire, and the gravel beds containing them, by Thomas F. Jamieson, F.G.S.—On the red clay of the Aberdeenshire coast, and the direction of ice-movement in that quarter, by Thomas F. Jamieson, F.G.S.

Victoria (Philosophical) Institute, March 20.—A paper on "Climatic Influences as regards Organic Life" was read by Dr. Gordon, C.B., honorary Physician to the Queen.

EDINBURGH

Royal Society, March 6.—Prof. Fleeming Jenkin, vice-president, in the chair.—Dr. Macfarlane communicated the results which he and Mr. D. Rintoul had obtained from experiments on the effect of flame on the electric discharge. A circular disk was supported near a Bunsen burner on an insulating rod, the centre of the disk, which lay in a vertical plane, being on the same level with the top of the burner. The disk could be charged positively or negatively (as desired) from a Holtz machine, and was in electrical connection with a quadrant electrometer, so that the differences of potential necessary for a discharge to take place between the disk and burner could be measured for each of the various experiments made. The effect of varying the distance between the disk and burner was carefully noted amongst other effects; but the most curious results seemed to be the marked difference in the behaviours of the flame under influence of the charged body according as the flame was luminous or non-luminous, or according as the charge was positive or negative. For example, though the non-luminous flame was (broadly speaking) affected similarly by the negative and positive charge, the luminous flame gave very different results in these cases, being drawn *towards* the negatively charged disk as if dominated by a strong blow-pipe blast, but being forced *down* upon the top of the burner when the disk was positively charged. The electrometer readings also showed interesting variations, being in general greater when the disk was charged negatively than when it was charged positively—Mr. J. Macfarlane, B.Sc., read a paper entitled observations on vegetable and animal cells, their structure, division, and history (Part 1). The paper dealt with the cells of Chara, a nucleus, nucleolus, and endonucleolus being shown to be present in all the active cells of the apical bud. After division of the sub-apical cell into node and internode, the former continued to divide, while the latter was completely arrested, though the earlier steps in division were taken, so that by virtue of the steady proliferation of the endonucleous and nucleolus the nuclei in such internodal cells as the third removed from the apex were multinucleolar. These nuclei then divided in the manner figured by Johow, so that the sixth internodal cell might be multinuclear, with multinucleolar nuclei. This same phenomenon was shown to occur in all the cells of the plant. Comparing his results with other observers, the author concluded that during division, the endonucleolus divides first; then the nucleolus, each of the daughter nucleoli forming an important centre of influence round which the nucleoplasm gathers; and finally, the nucleus, depositing in so doing a septum, and forming a nuclear spindle or barrel, which is most evident where the cell is most vacuolated. In reference to this continued activity of the cell-contents after cessation of cell division, which seemed to be universal among plants, relative nutrition was considered an important factor—cells with only a moderate supply of pabulum remaining multinucleolar, and the more highly nourished becoming multinuclear, a state of plant-cells which the author regarded as being commoner than had, even recently, been supposed.—Mr. Patrick Geddes communicated a paper by Mr. F. E. Beddard, B.A., Oxon, on some points in the anatomy of the nervous system of the pond-snails, Planorbis and Lymnæus.—Mr. E. Sang, in a paper entitled "A Critical Examination of Two Cases of Unusual Atmospheric Refraction described by Prof. Vince," argued that, as the drawings represented in their design and perspective nothing that could ever be seen, and as the diagrams and verbal descriptions were not consistent with each other, the well-known phenomena described by Vince were not cases of mirage at all.—Prof. Crum Brown read a description by the patient himself of a case of dyspeptic vertigo, and added in a few sentences the physiological explanation of the curious sensations experienced.

BOSTON, U.S.A.

American Academy of Arts and Sciences, February 9. —President Lovering in the chair.—Prof. A. E. Dolbear exhibited his new telephone. The peculiarity of this instrument consists in the receiver. This is formed of two parallel metallic plates separated from each other by a thin layer of air. One plate is fixed, and is connected with one terminal of a small Ruhmkorf coil; the other plate can vibrate, and is connected with the other terminal of the coil. When a transmitter is placed in the primary circuit of the Ruhmkorf coil, the attractions between the two metallic plates reproduce the sound-waves sent into the transmitter. Conversation has been carried on over 250 miles of land lines and 350 miles of submerged cable with the aid of this instrument.—Prof. F. W. Putman, curator of the Peabody Museum of Archæology at Cambridge, exhibited a number of specimens of pottery of the mound-builders of North America, which illustrated conventionalisms in ancient American art.—An interference prism for producing interference striæ was exhibited by Mr. C. E. Kelley. This consisted of two pieces of glass, separated at one end by one thickness of tinfoil, and at the other by two thicknesses of foil. By sliding the prism in front of the slit of a spectroscope, any suitable number of striæ could be produced.—Mr. N. D. C. Hodges reduced Maxwell's

law of distribution of energy among the particles of a gas from the principle of least action.—The following papers were presented by Prof. H. B. Hill, of Harvard University: Dibromacrylic acid; relations of dibromacrylic acid to two different tribrompropionic acids; certain tetra-substituted propionic acids; on the constitution of the substituted acrylic acids.—Dr. Asa Gray, of Harvard University, contributed the following: Studies of Solidago and Aster; *Novitiæ arizonicæ*, &c., characters of new plants chiefly from recent collections in Arizona and adjacent districts.

VIENNA

Imperial Institute of Geology, February 21.—The following papers were read:—F. v. Hauer, on the meteorites of Mocs (Transylvania).—Th. Fuchs, Bathymetrical distribution of the deep-sea fauna.—A. Bitter, on the Tertiary formation of the Vicentinian Alps.—Prof. Szabo, on the principles which enable us to determine the trachytes in their chronological relation.

March 7.—F. v. Hauer, communications on the Rhætic fossils of the Ligurian Alps.—O. Lenz, on a geological map of Western Africa.—V. Uhlig, on the Cephalopod fauna of the strata of Rossfeld.

Imperial Academy of Sciences, March 9.—L. T. Fitzinger in the chair.—The following papers were read:—E. Hering, contributions to general nerve and muscle physiology. Part ix. nerve excitation and nerve current.—R. Schram, auxiliary tables to chronology.—L. Heitinger, preliminary note on glutamic acid and pyrrol.

March 16.—L. T. Fitzinger in the chair.—Ph. Knoll, contributions to the theory of respiratory innervation. Part i. respiration during excitation of the cervical part of vagus by its own current.—T. V. Janovsky, on sulphonic acids of azobenzol.—V. Zepharovich, supplement to the already published crystal forms of some camphor-derivates, especially on the forms of camphor-bibromide.—M. Tüllich, a sealed packet dealing with a mechanical problem.—E. v. Dunikowski, on the Spongia, Radiolaria, and Foraminifera of the Lower Liassic strata of the "Schafberg," near Salzburg.—T. Kachler and T. Spitzer, on two isomeric camphor bibromides from camphor monobromide.—L. v. Pebal, on the use of electromagnets for mechanical separation of minerals.—E. Brücke, on testing urea by oxalic acid.—E. Stefan, on the magnetic screen-action of iron.—K. Ginzel, astronomical researches on eclipses.—A. v. Obermayer, on the diffusion of gases, Part ii.

PARIS

Academy of Sciences, March 20.—M. Jamin in the chair.—The following papers were read:—On some applications of the theory of elliptic functions, by M. Hermite.—Double decompositions of haloid salts of mercury; conclusions, by M. Berthelot.—Note on the use of superphosphates on calcareous soils of the south coast of France, by M. de Gasparin. The practice has sprung up there within the last two or three years; it proves beneficial to natural or artificial meadows. In a commercial superphosphate analysed, the author found two parts, out of twelve, of phosphoric acid, engaged in the state of phosphates insoluble in water; and ten in that of trihydrated phosphate, to which the agricultural effects are due. The lime and part of the iron were in the state of sulphates.—Letter of N. Fuss on large objectives, found by M. Truchot among the papers of Romme, Member of the Convention, by M. Faye. Fuss, an eminent member of the St. Petersburg Academy, consulted by Romme, indicated the limits then attainable, and gave precise calculations, by Euler's method, of a triple objective, 16 inches diameter, of short focus, with six well-conceived oculars. Romme probably meant to excite, by Fuss's letter, the emulation of French opticians, but events made him lose sight of this.—Theory explicative of the climatological *régime* observed in France on the Oceanic coast since 1880, and the disappearance of the sardine on this coast since the same time, by M. Blavier. See our Notes last week. The supposed displacement of the Gulf Stream is attributed to an exceptional quantity of ice in the region of Davis Straits, obstructing the polar current.—On the action of deformation through shock, compared with that through continuous pressure, by M. Marchal.—Observations of the planets 221 and 223, at Paris Observatory, by M. Bigourdan.—On hypercycles, by M. Laguerre.—On the theory of uniform functions of a variable, by M. Mittag-Leffler.—On mechanical integration, by M. Abakanowicz. He describes an apparatus demonstrating the principle of his integrators (a principle lately applied by Mr. Boys).—Relation between the law of Bouguer-Masson and the phenomenon of Purkinje, by MM. Macé de Lépinay and Nicati. This law applies to each of the simple spectral radiations (at least within the limits of experiment). The constant ratio indicated in it is the same for all radiations of wave-length greater than $\lambda = 5{\cdot}12 \times 10^{-5}$ approximately; beyond that, the ratio increases towards the violet.—Observations *à propos* of a recent note, by M. Violle, on the boiling temperature of zinc, by M. Troost. M. Violle seems to have overlooked later experiments by MM. Deville and Troost, which gave a figure (942°) little different from that obtained by M. Becquerel.—On new combinations of nitric acid and acetic acid with ammonia, by M. Troost. He indicates two of each kind, and their properties.—Action of acid solutions on protoxide of tin, by M. Ditte.—Action of ozone on salts of manganese, by M. Maquenne. Ozone easily produces transformation of protoxide of manganese into permanganic acid, conformably to thermal theory; and the transformation is complete.—Heat of formation of sulphocyanic acid and some sulphocyanates, by M. Joannis.—On the clarification of must for manufacture of champagne, by M. Jean. For this it is necessary to determine the amount of tannin which will be made insoluble by albuminoid matters, and the amount necessary to precipitate the whole of the gelatine added in fining. M. Jean uses a titrated solution of iodine for the purpose.—On the Kola nut, or Gourou, or Ombéne (seeds of *Sterculia acuminata*, Pal. de Beauvois), by MM. Heckel and Schlagdenhauffen. This nut, playing in Africa a *rôle* like that of *Maté* and *Coca* in America, contains more caffeine than the best coffees, and wholly in the free state; a good deal of theobromine, and a notable quantity of glucose; it has three times the starch of seeds of *Theobroma*, little fatty matter, a special tannin, and a red colouring matter.—On the richness in hemoglobin of the blood of animals living in high regions, by M. Bert. While the maximum quantity of oxygen absorbable by blood of herbivorous mammalia in France is 10 c.c. to 12 c.c. per 100 c.c. of blood, he finds the blood of several animals (lama, alpaca, stag, sheep, &c.) above Paz, Bolivia, which is 3700 m. high, capable of absorbing amounts from 16·2 c.c. to 21·6 c.c. These latter have thus a more abundant store for the requirements of their life.—On pancreatic digestion, by M. Duclaux.—On the existence of segmentary organs in certain isopod crustaceans, by M. Huet.—On the *Macroscincus coctei*, D. B., recently arrived at the menagerie of the Museum of Natural History, by M. Vaillant.—On the crystalline forms of zirconia, and deductions to be drawn from them for the qualitative determination of zircon, by MM. Lévy and Bourgeois.—On the barometric heights of January 17, 1882, and of the year 1821, in the South of France, by M. Vignier.

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THURSDAY, APRIL 6, 1882

THE ORIGIN OF THE SIGNS OF THE ZODIAC

The Unicorn: a Mythological Investigation. By Robt. Brown, Jun. (London: Longmans, Green, and Co., 1881.)

Astral Origin of the Emblems and Hebrew Alphabet. By J. H. Broome. (London: Edw. Stanford, 1881.)

IT is perhaps unjust to Mr. Brown's very attractive and suggestive book to couple it with the wild and ignorant lucubrations of the Rev. J. H. Broome. Mr. Brown has collected his facts from the latest and best authorities, and displays a wonderful amount of wide reading. His main object is to show that the unicorn of heraldry is the last faded representative of the horned moon of early mythology who struggles in vain with the solar lion, and among other curious points which he seems to have made clear is that the *Triquetra* of Sicily, the three legs of the Isle of Man, is the lunar ass of the Bundehesh with the triple legs. His book supplies another illustration of the close connection that exists between mythical astronomy and mythical zoology. As for Mr. Broome it is sufficient to say that he supposes the square Hebrew characters to constitute an independent alphabet of early origin, and the zodiac of Denderah to be "the oldest planisphere in the world, apparently referring to a time when the winter solstice, 4000 B.C., was quitting Pisces to enter Aquarius." Before he again commits himself to print, a study of some elementary work on the history of the alphabet, as well as some acquaintance with Hebrew and Arabic, would be advisable.

The subject, however, which he has attempted to handle is really an interesting one. The origin of the signs of the zodiac is a question which we have but recently obtained materials for answering. Even the origin and meaning of the symbols by which they are represented are unknown to most of those who are in the habit of using them. Some of these symbols, certainly, are plain enough: it is not difficult, for instance, to discover the horns of the bull in the symbol of Taurus, or the arrow in that of Sagittarius. But the meaning of others, such as the symbols of Virgo, of Scorpio, or of Capricornus, is not so self evident. These symbols, however, are of comparatively modern invention, and first came into use along with the symbols still employed by astronomers to denote the planets. In an interesting article upon the latter in *La Nature* last January, it is pointed out that they cannot be traced further back than the tenth century, and owe their origin to the connection the alchemists believed to exist between the planets and the metals. The precise forms of the symbols were not fixed immediately, and Letronne (*Revue archéologique*, iii. p. 261, 1846) maintains that at first the initial letters of the names of the planets were employed, of which the Greek Z, still representing Zeus or Jupiter, is the sole survival. The symbols of Mercury, of Venus, of Mars, and of Saturn are respectively pictures of the caduceus, the mirror, the spear and shield, and the sickle which characterised the deities after whom the planets were named. The cross which surmounts the globe of the earth points to Christian influence, and is probably not older than the sixteenth century, while the trident of Neptune has been substituted for the L. and V. of the name of Le Verrier only within the last half-century, and the symbol of Uranus is little more than the initial H of the name of Herschel.

But modern though the symbols of the planets and zodiacal signs may be, it is quite otherwise with the signs themselves, and the majority of the names by which we still call them. Recent research has shown that the general voice of classical antiquity was right in regarding the Chaldeans as the first to map out the path of the sun during the year into separate regions, or constellations. Copies made by Assyrian scribes of older Babylonian works on astronomy have been found in the library of Nineveh, and are now in the British Museum. From these we may form some idea of the astronomical notions which prevailed among the Babylonians 4000 years ago, as well as trace almost to their beginning the so-called Signs of the Zodiac.

The primitive population of Babylonia, now known by the name of Accadians, did not belong to the Semitic race, but spoke an agglutinative language like the Finns or Turks of to-day. It was they who first made Chaldea famous for its study of astronomy, and it is to them that the Signs of the Zodiac are due. Each sign represented a month of thirty days, and the signs and months were accordingly called by common names. As far back as our records carry us the year began with Aries, but we have indications that the names of the zodiacal signs were originally given in that remote epoch when the vernal equinox still coincided with the entrance of the sun into Taurus. At all events the Accadian name of the second month and second sign is that of "the directing Bull," a name which could have a signification only when the Bull directed the course of the year.

Why the opening of the year was thus placed under the protection of the Bull we are now able to explain. The ecliptic, or "path of the sun" as it is sometimes expressly called, was also termed "the furrow of heaven," and the planet Jupiter was commonly known as "the planet of the furrow of heaven," or "the bull of the sun." The sun-god, Merodach, when regarded as passing through the zodiacal signs, was addressed as Gudibir, "the bull of light," which must, therefore, have been another way of naming the ecliptic. Since the Accadian term for planet literally signified "old sheep," while Arcturus, the Bootes of the Greeks, was called "the shepherd of the heavenly flock," it is evident that the agricultural population of early Babylonia looked upon the sky as a vast field, filled with flocks and herds, where the sun, like a toiling bull, "directed" the plough through the bright furrow of heaven. The belief that the celestial bodies were animals was not confined to the Accadians; we find it prevailing among uncultivated tribes all over the world. The only way in which primitive man was able to explain the motions of the stars and planets was by supposing them to be endowed with the same life as the animals by whom he was surrounded.

The origin of the name of Aries is less clear. In Accadian the sign is called "he who dwells on the altar of uprightness," and is explained to mean the god Bel. Possibly we have here an allusion to the Assyro-Phœnician

legend of the sacrifice by Bel of his only son, the Sun-god, for whom a later and more humane age substituted the ram. In the tariffs of Carthage and Marseilles a ram takes the place of the human victim of the earlier cult.

The usual Accadian name of the third month was that "of bricks," on account of the suitableness of May for house-building; but I have also found it called "the double one," in reference probably to the twin stars which were supposed to preside over it. Gemini is of course the modern descendant of this title. Cancer I cannot account for, and the name was perhaps of Greek origin, like Libra, which, as we learn from Achilles Tatius, was originally denominated the Claw of the Scorpion. Leo is at present equally obscure, but Virgo goes back to the Accadian sign of "the errand of Istar," a name due to the belief that it was in August that the goddess Astarte descended into Hades in search of her betrothed, the Sun-god Tammuz or Adonis, who had been slain by the boar's tusk. The month and sign which follow were dedicated to "the illustrious mound," the building of the tower of Babel being believed to correspond with the autumnal equinox. "The scorpion" was the chief star of the next month, the usual name of which, "the month which faces the beginning (of the year)," seems to prove unmistakably that the year began with Taurus when the Accadians first named the months and signs. I cannot explain Sagittarius, but the goat was the Accadian name of the constellation Capricornus, and "the rainy season" was the title given to the month which was watched over by Aquarius. Finally, "the month of sowing" was that in which the Sun-god in his journey through heaven was called "the fish of Hea," the god of the sea.

It is evident from this that several of the names had a mythological parentage, and were due to the fact that certain myths were localised, as it were, in particular months. But other names equally clearly originated in the peculiarities of the season when the sun was in a special sign of the zodiac. This is certainly the case with Aquarius, and it is probable that fish were particularly abundant under Pisces when the lowlands of Babylonia had been inundated by the rains. Other names, again, were derived from the chief stars which lay near the path of the sun; and the stars, as we have seen, were imagined to be endowed with life and so compared with the animals of this nether earth. Among the names of the stars preserved to us in the Assyrian tablets, a large proportion are those of beasts and birds. It was these which gave the signs of the zodiac their zoological appearance, and caused the whole circle of signs to be designated by the Greeks the ζωδιακός, or "circle of animals."

A. H. SAYCE

THE GEOLOGY OF SUTHERLAND

Geological and Mineralogical Map of Sutherland. By M. Foster Heddle, M.D., F.R.S.E., &c., President of the Mineralogical Society of Great Britain and Ireland.

ANYTHING relating to the Geology of Sutherland has a great interest for British geologists. It was there that the battle of the "North-West Succession" was fought out by Murchison, whose conclusions have been acquiesced in by most geologists. Notwithstanding the evident simplicity of the structure of the country, there have always been some who have demurred from his interpretation, and who, discovering a few inaccuracies in his work, have endeavoured to invalidate its general results. The last phase of this dissent has just appeared in the form of a geological and mineralogical map by Prof. Heddle, and accompanying papers on the Geognosy of Sutherland, published in the *Mineralogical Magazine.* The map clearly shows a lower gneiss separated by the wreck of a wide-spread unconformable formation of sandstones and conglomerates from a higher group of quartzites, limestones, and schists. Thus far it corroborates Sir Roderick. The author however tries to prove from the evidence afforded by chemical analysis that the Durness limestone with its lower Silurian fossils has no relation to any other rocks in the country, and consequently that there is no evidence of any other part of the Highland rocks belonging to the Silurian system. For this information we require to have recourse to the "papers," as the map only indicates that the Erribol and Assynt limestones, which Murchison and most geologists have identified with those of Durness, are dolomitic. They are therefore expressed by different colours. The physical and palæontological evidence, however, appears to be entirely against this notion.

It is probably quite true, as Murchison himself pointed out, that at Durness the junctions of the limestone with surrounding rocks, whether upper or lower, are chiefly lines of fault. But it is no less certain, from the same testimony, that this limestone, with its admittedly Lower Silurian fossils, is seen to lie conformably upon and to form part of a lower quartzite, and itself to contain bands of quartzite. No later rock is seen to lie upon the limestone at Durness; but most geologists who have visited the locality appear to have no hesitation in identifying this limestone with the band which runs on the top of the lower quartzite from Erribol through Assynt far into Ross-shire. Dr. Heddle maintains that the identification must be wrong because chemical analysis shows the composition of the limestone to be different. Chemical analysis, though a useful help, is not always a safe basis for stratigraphical work. In the face of distinct palæontological facts, it must at once be set aside. Some of the same fossils which occur in the Durness Limestone are found also in strata associated with the Erribol and Assynt Limestones. The *Serpulites Maccullochii*, so characteristic a fossil of the zone immediately below the Assynt Limestone, occurs also in the limestone of Durness. Orthoceratites have been detected in the limestone of Assynt.[1] The cause of the difference in composition between the rocks at Durness and in Assynt may very properly be made the subject of chemical investigation, but all the analyses in the world cannot overturn the evidence of recognisable fossils.

The Assynt and Durness area is the only part of Dr. Heddle's map which has been worked out in detail, and which gives a fair idea of the geological structure of the ground. On a map of such a scale as half an inch to a mile, one would naturally have expected marked petrographical bands, and the general disposition of the rocks, to have been clearly distinguished. But in these respects the author has not availed himself of the opportunity

[1] "Siluria," 4th edit. p. 166 (*footnote*).

offered by the map, nor of his advantage in possessing so extensive a knowledge of mineralogy. He might as well have used a map one-fourth the size, which would have given all the detail he has published, in sufficient minuteness for the illustration of his papers. It is extraordinary, for instance, that not the slightest indication of structure is given, over the whole of the area of the older gneiss. No one can tell from the map, that the strike of this rock is nearly at right angles to that of all the other rocks. It is equally remarkable, that where indications of structure have been inserted, they are, in some cases at least, obviously imaginary. Lines of fault are recklessly drawn along the bottom of lakes, where they could not possibly have been observed, and where, as they coincide with the strike of almost vertical beds, they would be extremely difficult to prove, even if the rocks were visible all the way. It is hard to understand why they should have been inserted, unless to support some theory of lake-formation.

Besides the more detailed mapping of the Durness and Assynt areas, the map makes a few additions to our knowledge, such as a greater extension of the Cambrian or Torridon sandstone, and the existence of a solitary outlier of Old Red Sandstone in the centre of Sutherlandshire.

The writer of the present notice has not had an opportunity of visiting the ground, but he is under the belief that the west of Sutherlandshire exhibits on a great scale the phenomena of glaciation. One would naturally look for indications of the moraines and other traces of old glaciers on so large a map, but these superficial markings are likewise conspicuous here by their absence. Only one moraine is marked by Dr. Heddle. Is this the only one in the county?

The index of colours is a model of confusion. The old gneiss is placed at the top, then in succession come the rest of the rocks up to the Old Red Sandstone, followed in reverse order by the Upper Oolite and lower members of the Jurassic system, Trias, the Durness limestone, Syenite, Granite, Porphyry, and Eruptive rocks. A more serious defect still is the want of acknowledgment of the sources of information from which the map has been largely compiled. The maps and papers of Macculloch, Murchison, Nicol, Geikie, and Judd, have all been made use of, and this should have been conspicuously stated on the map itself.

OUR BOOK SHELF

A Year in Fiji; or, An Inquiry into the Botanical, Agricultural, and Economical Resources of the Colony. By John Horne, F.L.S., Mauritius. (London: for Her Majesty's Stationery Office, 1881.)

THIS report gives an extremely interesting sketch of the food products of the Fijis. Mr. Horne's tour, which occupied a year, was made in 1877, and he was specially commissioned to report on the sugar culture in these islands.

Beginning with an account of his tour through the different islands of the group, we have then a chapter on the chief peculiarities of their flora. The flora he considers still very imperfectly known, and he was enabled to add some 300 species to Dr. Seeman's list. Here we find ourselves obliged to protest in the strongest possible way against the extremely objectionable manner in which the scientific names are printed in this report: the initial letters of all the generic terms are printed in lower case, and not, as is the universal custom, with a capital letter; and thus not only the usefulness, but the appearance of the book, is interfered with. We acquit the author of blame in this matter, for he may never have seen the proofs; but the reader for press, with the list of Fiji plants which appears on page 256 before him is without excuse.

Fruit is plentiful in Fiji, and might with advantage be exported, especially bananas, pine-apples and oranges. Attention is called to the necessity of re-foresting. Of the agricultural products, mention is made of copra, sugar, cotton, maize, tobacco, and coffee. Of copra, the dried kernel of cocoa-nuts, there was exported in 1878 122,194*l.* worth, but little oil was made, the copra paying better. The sugar crop is steadily on the increase: for 1880 it was estimated to produce 60,000*l.*, and when fully developed, Mr. Horne estimates a possible yearly make of about 200,000 tons. Coffee-trees thrive well, and the coffee export in time will be second only to sugar. Cotton is being displaced by the sugar-cane. The trees yielding caoutchouc in Fiji are Apocynaceous, belonging to the genera Tabernæmontana and Alstonia. The Fijians collect the juice which exudes from the broken leaves and branches in their mouths. Several mouthfuls are then rolled into a ball, and the juice congeals so quickly that it requires very little working with the fingers before it is dry and ready for the market. Samples sent to England were priced as high as 2*s.* 6*d.* a pound. Sandal-wood is becoming scarcer and dearer each year in Fiji; in 1878 it was worth 10*l.* a ton.

In an appendix we find a series of propositions for a forest ordinance for Fiji, which, carried into effect, would no doubt be of great service to this British colony.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

On a Perpetual Form of Secondary Cell

I HAVE succeeded, after many fruitless attempts, in discovering an indestructible material which can be substituted for lead, as the negative or oxygen-bearing plate of the Faure accumulators, without sacrificing any of the extraordinary good qualities which that excellent form of secondary couple possesses, excepting only its cheapness of construction.

The only substance which I have yet found to be such an effective substitute for the lead-plate, is platinum-foil, which has been coked at a high heat with lampblack for some days in a pottery kiln, until its smooth surface becomes thereby roughened with a dull drossy coat. To whatever assimilation of metalloids from the pure lampblack, or from the kiln-furnace gases, this surface-alteration of the clean platinum is due, it seems probable that the electrolytic oxygen in the charging process removes the contamination, leaving the platinum-surface in the fine state of nearly molecular sub-division necessary for forming conducting-contact with the ozone-, or oxygen-imbued dioxide. For the result is a current of very nearly the same copious quantity, or density of flow, and of nearly the same tension and storage capacity as that commonly yielded by the usual mode of construction, and of charging and discharging a Faure accumulator with lead plates.

The processes of maturing or "forming" the coked platinum-plate, and of charging and discharging it, exactly resembles the usual processes with a lead one. At the same time, if leakage by local action is not entirely prevented, it must at least be reduced to a minimum on a plate of platinum, and such a plate is not liable, like a lead one, to suffer gradual destruction by occasional accidental wants of watchful attention against overcharging it.

I have not tried the effect of electro-depositing platinum upon it as a means of roughening the surface of platinum foil; but experiments with clean platinum in sulphuric acid, and with clean platinum in strong solution of caustic potash, and again with iron-wire gauze, and even with iron-wire gauze spread with fine iron-filings, in the latter liquid, as supports for the layer of dioxide, sufficiently evinced that mechanical roughness alone is quite unproductive of the close intimacy of contact between the peroxide and the metal plate required to establish the necessary kind of rheomotive continuity between them. But on the other hand, if iron in caustic potash could by any means be brought superficially (perhaps by kilning it in oxide of manganese) to as intimate conjunction during the charging process with lead peroxide, as platinum-foil is brought by a preparatory coking of its surface, it would be an equally effective and equally indestructible substitute for a lead plate with platinum, and as far as I have observed it, as retentive an accumulator of the charge communicated to it as platinum itself is either in dilute acid or in caustic potash.

But on an iron conductor in a solution of caustic alkali, dioxide of lead itself must be originally spread out; since this liquid seems incapable (at least without protracted action), although it soon forms the spongy-lead layer opposite to it, of converting the minium into a dioxide layer. The electrolysis of water by iron electrodes in a solution of caustic soda and of caustic potash, also, is singularly rapid, attended perhaps by a minimum counter-force of polarisation, and by little production of ozone, so that the proportion of oxygen absorbed to the oxygen wasted and given off in charging,[1] unless a weak current only is applied, is less than with dilute sulphuric acid, and the liquid has an inconvenient tendency to froth up. But in regard to storage and retention of a charge communicated to it, and in its manner of furnishing the return or secondary current, this arrangement appears to be just as efficacious as one with a clean platinum conductor.

A cell made with minium laid on two clean platinum-leaves of a pair of ordinary pint Grove-cells, weighed when placed with acid in its glass jar (not much larger than a glove's thumb- or finger-stall), just seven ounces. Yet when well charged it rang a call-bell continuously for eight hours. When afterwards re-charged, and washed, and left to dry unavoidably for a fortnight, on simply immersing it then in a solution of caustic potash, it rang a bell with a few intervals of intermittence of the current, for twenty hours before it was exhausted. It still continues with similar intermittences of a few day's rest to furnish residual bell-ringing currents of two or three hours' duration each, sufficiently proving the extreme hardiness and retentiveness of its construction. A rather bulkier cell formed with two coated sheets of iron-wire gauze in caustic potash comported itself in an exactly similar manner, having just now, five days after being charged, and without yet ceasing its clatter, rung a bell continuously for thirty-six hours.[2]

But between these small messenger-currents and the substantial stream that can be drawn from a properly-formed Planté or Faure cell with lead-plates of the same size, there is as much difference as between a caged song-bird and a slipped falcon; and it has afforded me extreme pleasure to be able to reproduce successfully the normal action of the lead accumulators with an indestructible metal plate as the negative conductor, by the fortunate possession and trial of a piece of platinum-foil roughened in the way described above, which was accidentally preserved from some former experiments on mossy incrustations produced on platinum surfaces by contact with carbon or with heated vapours in a carbonising kiln.

Although already convinced of its correctness by these experiments, I owed to the pages (pp. 382-83) of Prof. Silvanus Thompson's excellent book of "Elementary Lessons in Electricity and Magnetism" which treat of secondary batteries, my first acquaintance with the general acceptance as an established fact of the view that gaseous polarisation of the plates by oxygen and hydrogen is in these extreme, as much as in ordinary weaker cases, the source of the secondary or return current in a secondary cell—that, for example, in Planté's cells the lead-plates acquire their high tension by "becoming with use coated with a semi-porous film of brown dioxide of lead, presenting a large amount of surface and holding the gases well"; and that by Faure's method of preparation, the improvement is effected that "cells thus prepared sooner acquire the effective spongy brown surface of dioxide of lead."

It is, in fact, a well-known result, and one which I can thoroughly confirm from the tests and observations to which I have submitted it, that whatever electromotive force the simple contact of dioxide of lead by itself may be sufficiently energetic to produce,[1] it is to a natural aptitude which it possesses besides for occluding ozone or nascent electrolytic oxygen in its pores, and probably also by undergoing at the same time chemical superoxydation, to which its remarkably high tension and effective electromotive deportment in secondary cells must really be ascribed. It is thus that a platinum cathode, by occluding electrolytic hydrogen in its substance, becomes electropositive, and that palladium similarly charged to repletion with hydrogen by electrolysis, even becomes at last spontaneously inflammable.

In Dr. Gore's treatise in the "Circle of the Sciences" on "Electro-Deposition," it is mentioned (pp. 55, 56) that in rapid negative depositions of antimony, the freshly-deposited metal is explosive to such a degree, with evolution of heat and of a cloud of white vapour at points where it is rubbed, that thickly plated articles are sometimes liable to sudden fractures and destruction by this accident, if incautiously handled, even for some hours after they are washed and dried. Either the storage of nascent hydrogen in the antimony, it is supposed, or of an unstable molecular form of antimony itself, is here effected also by the galvanic current; and ozone is a form of oxygen which is only producible by similar means of exciting and provoking molecular accumulation or storage of energy.

The absorbed oxygen's state in the peroxide film would seem to be, as that of occluded hydrogen has appeared to be in metals, one of easy dissociation from, joined and consorted to physical admixture with, some precarious chemical oxide or compound depending, as it seems reasonable to suppose, for its existence in some degree upon the quantity of its free materials present in the substance with it. But the freedom with which the gases are able to diffuse themselves everywhere through the film or metal, is no doubt a sufficient and suitably adequate condition to maintain the precarious compound's chemical integrity, so as to make it a retentive source of energy, as long as the uncombined gas-portions with which it is surrounded in the film or metal, are not withdrawn from it by a galvanic discharge arising from completion either of the secondary circuit or else of some unavoidable channels of destructive local actions.

The contact theory of current excitation requires such close linkage together of circuit elements, for the establishment of a current through them, that if the highly negative peroxide film should be severed by liquid, or by any substance equally inert to a liquid in the voltaic chain, from its metal plate conductor, its effective electromotive force would immediately disappear from the circuit. This is the ground on which I surmised the need, above, of such a perfect contact between the peroxide film and its metal carrier that only a molecular union produced between them in the charging process could well be expected to prevent the intrusion of the liquid of the cell, to the current's detriment, between the actively electromotive gas-absorbing layer and its adjoining inoperative metal-plate conductor, or battery-connection.

It is, again, to the hints contained in a paragraph on a later page (p. 391) of Prof. Silvanus Thompson's book, describing the phenomena and the modes of producing Nobili's rings, that I owe the suggestion of trying the experiment of iron-gauze electrodes in solution of caustic alkalies, which produced a very satisfactory form of secondary cell, showing at least a possibility of perhaps effecting in it some future practical improvements.

A. S. HERSCHEL

College of Physical Science, Newcastle-on-Tyne, March 20

Aristotle on the Heart

ALLOW me space to say, in reference to Dr. Richardson's letter in NATURE, vol. xxv. p. 505, that my note on Aristotle's account of the heart, though so lately published, was written many years ago, and therefore in complete independence of Prof. Huxley's article on the same subject. This fact, of course, in no way lessens Prof. Huxley's complete rights of priority; but I

[1] See Drs. Gladstone and Tribe's experiments and remarks on the relative absorptions and losses of the electrolysed gases in charging a lead-cell; "The Chemistry of the Planté and Faure Accumulators," Part II.; NATURE, xxv. p. 462.

[2] This cell's current lasted forty hours; but a week later a residual current of two more hours' duration was extracted from it.

[1] This was shown by F. Munck, in *Poggendorff's Annalen* (*circa*, 1835), to surpass negatively that of all the other metallic oxides, not excepting the black oxide of manganese, by means of the usual contact experiments with a gold-leaf electroscope and condenser.

am anxious to state it, in order to clear myself of any suspicion of having borrowed from that distinguished writer without acknowledgment. W. OGLE

April 2

Rime Cloud observed in a Balloon

IN his letter, inserted in NATURE, vol. xxv. p. 507, Dr. Hermann Kopp says that "when Kratzenstein (1744) advocated the opinion anticipated by Halley (1686), that water-vapour may be condensed in a vesicular state, he availed himself of the *observation that in clouds and mists and condensed steam over boiling water, a rainbow is not to be observed in reflected light.*" I have good grounds to suppose these negative observations were made only because the intensity of reflected light was not sufficient, as a white rainbow is produced under these circumstances. In support of these assumptions, I may be allowed to quote an observation published by M. Faye in vol. xxviii. of the *Comptes rendus*, 1849, p. 244, where the celebrated astronomer says:—

"J'ai observé cette nuit un phénomène que je signale aux personnes qui l'occupent d'optique méteorologique. En sortant d'une salle de travail qui donne sur le parc de l'observatoire, j'ai remarqué que la lumière d'un bec de gaz en arrière produisait en face de moi par la porte entrouverte un arc-en-ciel blanc semblable à un halo lunaire . . . Cet arc-en-ciel blanc doit être aisement réproduit par les temps de brouillards; on pourrait le faire naître a la lumière électrique . . . et l'étudier plus complétement que je ne l'ai fait."

It is to be regretted that the suggestion of the illustrious astronomer has not been taken into account by the physicists in an age when the electric light is so frequently in their hands. I believe that this kind of experimentation will elucidate the controversy, and afford some new ideas on the constitution of clouds under several circumstances, as artificial clouds may be produced by using jets of steam or condensing steam over a boiler. I believe a white rainbow, which is really the corona of the aëronauts, would appear under these circumstances, and the phenomenon would take another aspect when electric light falls on solid snow. The electric lighthouses now building will afford to the keepers many opportunities of making this observation. I take advantage of this opportunity to ask M. Hermann Kopp if he will obligingly suggest some observations to be made in a balloon for examining whether the minute particles of water are liquid or solid. By doing so, he will confer a great benefit on aëronauts next winter. W. DE FONVIELLE

The Kunnungs

HAVING just returned from an exploring expedition east of Asam, where I met a number of "Kunnungs," I may report that they appear distinct, both in language and physique, to the Naga groups south of Asam, and, in language, have affinities with Singphos. Those I saw, were with one exception, much more prepossessing in appearance than the other hill-savages, and in colour very pale, *i.e.* 33 and 45 of Broca's scale. I have got a limited vocabulary. They are great iron and steel workers, and extend from the Mli-kha to what they call the boundary of China, living on pile platform dwellings, raiding like all the hill-men about, having "morongs," or separate houses for the unmarried; like others, also, their "morals" (as we should say) begin with marriage.

I am now preparing some notes of my trip, and send this as I am writing, as it may interest some to know whom these people seem like. S. E. PEAL

Subsagar, Asam

Burrowing Larvæ

IN his letter *ante* p. 265, Dr. Hagen states that he had "been informed by M. Lesquereux that a large number of magnolia leaves, from the Tertiary of Alaska, show serpentine trails not larger than a thread, running all over the leaves, apparently under the epithelium," and Dr. Hagen evidently believes them to be the mines or burrows of some Tineid larvæ. Precisely such mines are now made in this country, in the leaves of magnolias, by a larva of the genus *Phyllocnistis*, Zell. The moth has not been bred from the larvæ, but the mine and larvæ are indistinguishable from those made by *Phyllocnistis liriodendronella*, Clem., in leaves of *Liriodendron tulipifera*, and doubtless it is the same species in both of these allied trees. "What is a species?" however, is a doubtful question in *Phyllocnistis*, at least in our American species. No species of this or any other genus is known to burrow in the leaves of any of the other genera of plants named in Dr. Hagen's letter besides Magnolia, Liquidambar, and Sassifras. Another *Phyllocnistis* mines the leaves of Liquidambar, and has been described by me under the name of *P. liquidambar-isella*, but it is probably identical with *P. vitifoliella*, Cham. The mine is similar to, but distinct from, that of *P. liriodendronella*. The larva which mines Sassafras leaves is that of *Gracilaria sassafracella*, Cham., but it leaves the mine at a very early stage of larval life, when the mine is too small to be recognised in a fossil leaf, unless it has been unusually well preserved. In this connection I will add that I distinctly remember having *somewhere* seen a figure, by Lesquereux I think, of a fossil leaf of a species of *Acer*, on which there were several blotches, one of which bore a strong resemblance to the mine of *Lithocolletis aceriella*, now made in leaves of *Acer saccharinum*; but as I saw only the figure, and not the fossil, I cannot be certain that it was a mine of that larva.

Covington, Ky., U.S.A., March 10 V. T. CHAMBERS

Vignettes from Nature

WILL Dr. W. B. Carpenter kindly tell us where in "South America" are the "coprolite diggings" from which he had "just seen a collection of sharks' teeth"? I am aware that at Bull River, South Carolina, North America, are vast deposits of "coprolites" (almost identical in character with those of our Suffolk Cray), which are largely imported into England from the United States. Of these Bull River sharks' teeth, &c., I have had many specimens. W. BUDDEN

Ipswich, March 23

Red Flints in the Chalk

AT one part of Caterham Valley, Surrey, there is an example of an abundance of red flints similar to that mentioned by W. Fream (NATURE, vol. xxv. p. 437). The colour is, doubtless, due to the presence of oxide of iron, but I have not tested it. I find that the red flints invariably contain the remains of sponges, the network of spiculæ of which, being coated with the oxide of iron, show up in crimson or orange on a ground of black flint, and are very beautiful objects under a lens. Thus it appears to me that the redness observable in these flints is mostly due to the inclosure of sponges which contain either oxide of iron or iron which afterwards became oxidised. The yellow oxide of iron is disseminated throughout the *chalk* itself, some strata being very much stained by it. JOHN BADCOCK, Jun.

270, Victoria Park Road, E.

ON THE DISPERSAL OF FRESHWATER BIVALVES

THE wide distribution of the same species, and of closely-allied species of freshwater shells must have surprised every one who has attended to this subject. A naturalist, when he collects for the first time freshwater animals in a distant region, is astonished at their general similarity to those of his native European home, in comparison with the surrounding terrestrial animals and plants. Hence I was led to publish in NATURE (vol. xviii. p. 120) a letter to me from Mr. A. H. Gray, of Danversport, Massachusetts, in which he gives a drawing of a living shell of *Unio complanatus*, attached to the tip of the middle toe of a duck (*Querquedula discors*) shot on the wing. The toe had been pinched so hard by the shell that it was indented and abraded. If the bird had not been killed, it would have alighted on some pool, and the Unio would no doubt sooner or later have relaxed its hold and dropped off. It is not likely that such cases should often be observed, for a bird when shot would generally fall on the ground so heavily that an attached shell would be shaken off and overlooked.

I am now able to add, through the kindness of Mr. W. D. Crick, of Northampton, another and different case. On February 18 of the present year, he caught a female *Dytiscus marginalis*, with a shell of *Cyclas cornea* clinging to the tarsus of its middle leg. The shell was ·45 of an inch from end to end, ·3 in depth, and weighed (as Mr. Crick informs me) ·39 grams, or 6 grains. The valves

clipped only the extremity of the tarsus for a length of ·1 of an inch. Nevertheless, the shell did not drop off, on the beetle when caught shaking its leg violently. The specimen was brought home in a handkerchief, and placed after about three hours in water; and the shell remained attached from February 18 to 23, when it dropped off, being still alive, and so remained for about a fortnight while in my possession. Shortly after the shell had detached itself, the beetle dived to the bottom of the vessel in which it had been placed, and having inserted its antennæ between the valves, was again caught for a few minutes. The species of Dytiscus often fly at night, and no doubt they generally alight on any pool of water which they may see; and I have several times heard of their having dashed down on glass cucumber frames, no doubt mistaking the glittering surface for water. I do not suppose that the above weight of 6 grains would prevent so powerful an insect as a Dytiscus from taking flight. Anyhow this beetle could transport smaller individuals; and a single one would stock any isolated pond, as the species is an hermaphrodite form. Mr. Crick tells me that a shell of the same kind, and of about the same size, which he kept in water "extruded two young ones, which seemed very active and able to take care of themselves." How far a Dytiscus could fly is not known; but during the voyage of the *Beagle* a closely-allied form, namely, a Colymbetes, flew on board when the nearest point of land was forty-five miles distant; and it is an improbable chance that it had flown from the nearest point.

Mr. Crick visited the same pond a fortnight afterwards, and found on the bank a frog which appeared to have been lately killed; and to the outer toe of one of its hind legs a living shell of the same species was attached. The shell was rather smaller than in the previous case. The leg was cut off and kept in water for two days, during which time the shell remained attached. The leg was then left in the air, but soon became shrivelled; and now the shell being still alive detached itself.

Mr. F. Norgate, of Sparham, near Norwich, in a letter dated March 8, 1881, informs me that the larger water-beetles and newts in his aquarium "frequently have one foot caught by a small freshwater bivalve (*Cyclas cornea ?*), and this makes them swim about in a very restless state, day and night, for several days, until the foot or toe is completely severed." He adds that newts migrate at night from pond to pond, and can cross over obstacles which would be thought to be considerable. Lastly, my son Francis, while fishing in the sea off the shores of North Wales, noticed that mussels were several times brought up by the point of the hook; and though he did not particularly attend to the subject, he and his companion thought that the shells had not been mechanically torn from the bottom, but that they had seized the point of the hook. A friend also of Mr. Crick's tells him that while fishing in rapid streams he has often thus caught small Unios. From the several cases now given, there can, I think, be no doubt that living bivalve shells must often be carried from pond to pond, and by the aid of birds occasionally even to great distances. I have also suggested in the "Origin of Species" means by which freshwater univalve shells might be far transported. We may therefore demur to the belief doubtfully expressed by Mr. Gwyn Jeffreys in his "British Conchology," namely, that the diffusion of freshwater shells "had a different and very remote origin, and that it took place before the present distribution of land and water."

CHARLES DARWIN

THE FISHERY EXHIBITION AT EDINBURGH

IT has now been placed beyond doubt that this exhibition will prove successful, so far as a great show of interesting exhibits is concerned. Such exhibitions, of course, partake in some degree of the nature of a commercial adventure—the projectors being dependent on the gate money to pay the expenses incurred, which are naturally heavy—although the prize list has been largely contributed to by private individuals and public bodies. Such an exhibition being a novelty will no doubt attract, from day to day, a considerable body of spectators, although it is deprived of many attractive features by reason of the place of exhibition not being fixed on the immediate sea-coast. It would have proved interesting, could the spectators have been shown the beam trawl at work, or have had displayed before them a suite of herring nets, or other items of the machinery of fish capture. Such apparatus will be largely displayed in the place of exhibition, but their effects cannot so well be judged as when they are seen in action. Upwards of seventy prizes are offered for "exhibits" and "essays"; the latter, indeed, seem to be a chief feature of the exhibition, and if they can be utilised for behoof of the public and the fisher people, some good may result. But, although a large number of prizes were given for essays at the Norwich Fishery Exhibition of last year, the public have not been made any the wiser in consequence. A very handsome surplus resulted from the Norwich exhibition—nearly a thousand pounds it is said. Why, then, has not a portion of that sum been devoted to the dissemination of the knowledge contained in the prize essays? As regards the "exhibits," they can always be seen and understood by those who please to look at them, and if there are half a dozen of the same sort, they can be compared one with the other, and the decisions of the judges can be criticised, so that persons in search of new boats or other fishing gear, can give their orders for the same in the direction they think most suitable. But with respect to the essays the knowledge contained in these productions—judging from what took place at Norwich—will remain buried in the brains of the committee! Of what possible use is it to bestow a prize on the writer of an essay, "On the Fish Supplies of Great Cities, with special reference to the best Methods of Catching and Packing," if the knowledge thus obtained is never to become public? The prize list of the Edinburgh Exhibition is rich in material for the essayist, many subjects of interest in the fishery world being selected for illustration, such as the salmon disease, oyster culture, the migrations and spawning of sea fish, the utilisation of fish offal, the best methods of preserving fish alive for markets, the pollution of rivers, the natural history of the herring, and twenty other subjects. In view of the still larger international fishery exhibition, which will take place in London next year, it is time this question of "what ought to be done with the prize essays," should be ventilated and settled. Up till this moment it remains a blot on the Norwich exhibition that none of the prize essays sent there have been made public. So far as we know, only one of the essays has become accessible; that is the essay, on the salmon disease, by Sir James Gibson Maitland, which, however, was printed at the baronet's own expense. The exhibition at Edinburgh will be very much on the lines of those which took place some years ago at the Hague and Arcachon, except that the most attractive feature of the latter exhibition will be wanting in the well-arranged aquarium. Neither in Edinburgh nor in London can we hope to compete with the great fishery show of Berlin, which was undoubtedly very complete, the American national exhibits being of much interest. At home we have no fishery collection of a national kind, if we except Buckland's Museum of Economic Fish Culture; and, so far, we are at a disadvantage with the United States, which possesses a very complete collection of fishery apparatus of all kinds. It is to be hoped, in the circumstances, that America will do for this country what it did for Germany, give us an opportunity of seeing and judging for ourselves how far

they are ahead of us in fishery economy. We shall doubtless be able, when the exhibition opens, to find some points of interest worthy of being alluded to in a future number of NATURE.

THE WINGS OF PTERODACTYLES[1]

THE first Pterosaurians discovered were recognised as flying animals, but were thought to be bats. As soon as their general structure became known, they were classed with the reptiles, although it was considered possible that their power of flight was due to feathers. Later their bones were mistaken for those of birds by various experienced anatomists, and others regarded them as sharing important characters with that group. Some anatomists, however, believed that the fore-limbs of Pterodactyles were used for swimming rather than for flight, and this view has found supporters within the present decade. A single fortunate discovery, made a few years since, has done much to settle the question as to the wings of Pterodactyles, as well as their mode of flight, and it is the aim of the present article to place on record some of the more important facts thus brought to light.

The specimen to be described was found in 1873, near Eichstädt, Bavaria, in the same lithographic slates that have yielded *Archæopteryx*, *Compsognathus*, and so many other Jurassic fossils known to fame. This specimen, which represents a new species of the genus *Rhamphorhynchus*, is in a remarkable state of preservation. The bones of the skeleton are nearly all in position, and those of both wings show very perfect impressions of *volant membranes* still attached to them. Moreover, the extremity of the long tail supported a separate vertical membrane, which was evidently used as a rudder in flight. These peculiar features are well shown in Fig. 1, which represents the fossil one-fourth the natural size.

The discovery of this unique specimen naturally attracted much attention at the time, and many efforts were made to secure it for European museums. The writer was then at work on the toothless Pterodactyles which he had recently found in the Cretaceous of Kansas, and believing the present specimen important for his investigations, sent a message by cable to a friend in Germany, and purchased it for the museum of Yale College, where it is now deposited.

The Wing Membranes.—A careful examination of this fossil shows that the patagium of the wings was a thin

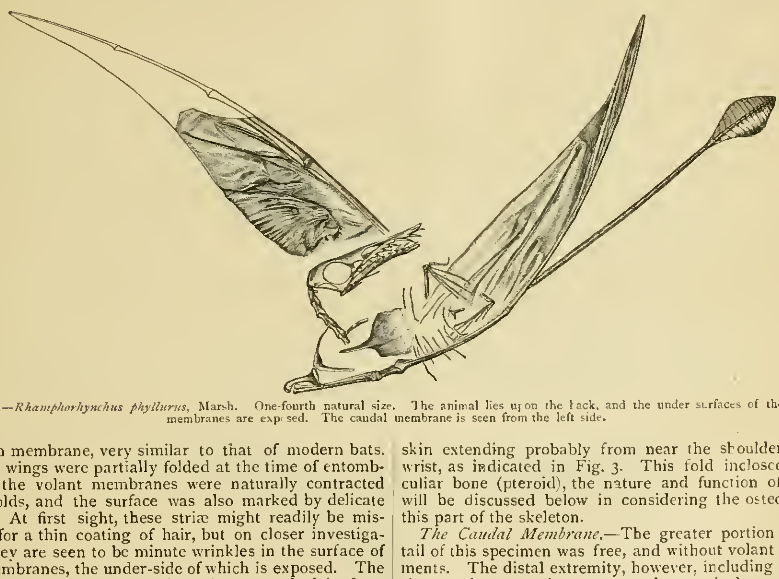


FIG. 1.—*Rhamphorhynchus phyllurus*, Marsh. One-fourth natural size. The animal lies upon the back, and the under surfaces of the wing membranes are exposed. The caudal membrane is seen from the left side.

smooth membrane, very similar to that of modern bats. As the wings were partially folded at the time of entombment, the volant membranes were naturally contracted into folds, and the surface was also marked by delicate striæ. At first sight, these striæ might readily be mistaken for a thin coating of hair, but on closer investigation they are seen to be minute wrinkles in the surface of the membranes, the under-side of which is exposed. The wing membranes appear to have been attached in front along the entire length of the arm, and out to the end of the elongated wing finger. From this point the outer margin curved inward and backward, to the hind foot.

The membrane evidently extended from the hind foot to near the base of the tail, but the exact outline of this portion cannot at present be determined. It was probably not far from the position assigned it in the restoration attempted in the cut given below, Fig. 3. The attachment of the inner margin of the membrane to the body was doubtless similar to that seen in bats and flying squirrels.

In front of the arm there was likewise a fold of the skin extending probably from near the shoulder to the wrist, as indicated in Fig. 3. This fold inclosed a peculiar bone (pteroid), the nature and function of which will be discussed below in considering the osteology of this part of the skeleton.

The Caudal Membrane.—The greater portion of the tail of this specimen was free, and without volant attachments. The distal extremity, however, including the last sixteen short vertebræ, supported a vertical membrane, which is shown in Fig. 1 and also in Fig. 2. This peculiar caudal appendage was of somewhat greater thickness than the patagial membrane of the wings. It was rhomboid in outline, and its upper and lower portions were slightly unequal in form and size. The upper part was kept in position by a series of spines, sent off one from near the middle of each vertebral centrum, and thus clearly representing neural spines. The lower half also was strengthened by similar spines, which descended from near the junction of the vertebræ, and hence were homologous with chevron bones. These spines were cartilaginous, and flexible, but sufficiently firm in texture to keep the membrane in an upright position.

The Scapular Arch.—The osteology of the scapular

[1] Communicated by the author. This article will also appear in the *American Journal of Science* for April.

arch and wings of Pterodactyles involves many interesting points, some of which have been discussed by anatomists from Cuvier to those of the present day, but with little agreement of opinion. The cause of this diversity of opinion is mainly due to the fact that the specimens examined have been either too small or too imperfect for accurate determination of their more obscure parts. Fortunately, the museum of Yale College has among its specimens of Cretaceous Pterodactyles (some 600 in all), quite a number with the scapular arch and wing-bones nearly perfect, and in position. These specimens were nearly all of gigantic size, having in life a spread of wings from fifteen to twenty feet. They were also destitute of teeth, and belong to the order *Pteranodontia*. Probably

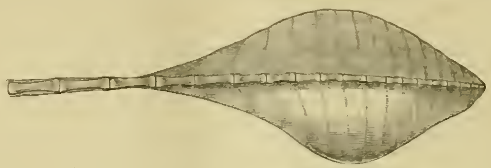


Fig. 2.—Caudal extremity of *Rhamphorhynchus phyllurus*, Marsh; natural size. Seen from the left side.

their great size induced special modifications of the scapular arch, which is here far more complicated than in any other members of the group.

In the Jurassic Pterodactyles, the scapula is usually bird-like in general form and proportions, the upper or distal extremity being free and compressed. This is the case in the specimen here described. The scapula and coracoid may be co-ossified, as in the present fossil, or remain more or less separate. No clavicles have yet been found. The sternum here shows no distinct facets for sternal ribs.

In the Cretaceous genus, *Pteranodon*, and probably also in some of the other gigantic forms from deposits of this age, the scapula and caracoid were not only solidly united, but the pectoral arch was further strengthened (1) by the ankylosis of several vertebræ, and (2) by the robust scapulæ articulating on opposite sides of the common neural spine of these vertebræ. This is virtually a repetition of the pelvic arch, on a much larger scale. The sternum also is massive, and shows well-marked facets for the sternal ribs. This peculiar method of strengthening the scapular arch has not been observed in any other vertebrates.

The Wing Bones.—The three principal bones of the arm (humerus, radius, and ulna), present such similar characters in all Pterodactyles, that they need not be considered here in detail. It is important, however, to bear in mind that the ulna, although but little larger than the radius, contributes the greater share of direct support to the enormously developed wing finger, which is on the outer or ulnar side of the hand. As this position has been a question of discussion among anatomists, it may be well to state, that the writer bases his opinion upon this point on the results of an examination of the best preserved specimens in European museums, as well as nearly all known in this country. The latter specimens settle the question beyond doubt.

The views expressed by anatomists in regard to the bones of the wrist and hand of Pterodactyles are almost as various as the specimens investigated. Some of the restorations of these parts that have been published from time to time, and repeated in text-books, have done much to propagate errors, and little to clear away the serious difficulties in the case. The main facts in regard to the carpus now known may be briefly stated as follows:—

In all Pterodactyles, there are two principal carpal bones, placed one above the other. These sometimes show indications of being composite, but their constituent parts have not been satisfactorily determined. On the inner side of the wrist, articulating with the distal carpal, there is a smaller bone, which has been called the "lateral carpal." In addition to these three bones, some American Pterodactyles have on the inner side three ossicles, which may be sessamoid bones. Two of these have been seen in a few Jurassic forms in Europe. Besides these, there is often found on the radial side of the wrist, and sometimes attached to it, a long, slender styloid bone, having a rounded articular head on its carpal extremity. This is the so-called "pteroid bone," to which allusion has already been made above. This bone

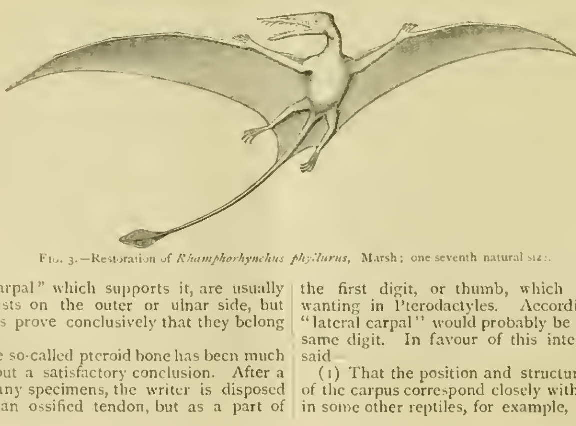


Fig. 3.—Restoration of *Rhamphorhynchus phyllurus*, Marsh; one seventh natural size.

and the "lateral carpal" which supports it, are usually placed by anatomists on the outer or ulnar side, but American specimens prove conclusively that they belong on the radial side.

The nature of the so-called pteroid bone has been much discussed, but without a satisfactory conclusion. After a careful study of many specimens, the writer is disposed to regard it, not as an ossified tendon, but as a part of the first digit, or thumb, which is often considered wanting in Pterodactyles. According to this view, the "lateral carpal" would probably be the metcarpal of the same digit. In favour of this interpretation it may be said

(1) That the position and structure of this appendage of the carpus correspond closely with that of the first digit in some other reptiles, for example, *Iguanodon*.

(2) The "lateral carpal" unites both with the distal carpal and with the "pteroid" by very free, well-defined articulations.

(3) In American specimens, the "lateral carpal" stands nearly at right angles to the wrist, and the "pteroid" is much bent near its articular end.

(4) In no Pterodactyle known is there any remnant of a digit outside the wing finger, where the membrane might be expected to retain it.

(5) This view would make the wing finger of the fifth digit, the same to which the membrane is attached in the hind foot.

Perhaps the strongest objection against this interpretation is the number of phalanges in the respective digits of the hand. These, however are not constant in the known Pterodactyles, and they vary much in other reptiles which have the digits highly specialised. This subject will be more fully discussed by the writer elsewhere.

According to the above interpretation, there are five digits in the hand of Pterodactyles, although not the five often given in restorations. The first digit, the elements of which have been considered, undoubtedly supported a membrane in front of the arm. The second, third, and fourth are small, and armed with claws. The large wing finger is the fifth, corresponding to the little finger of the human hand.

The metacarpal bones are much elongated in the Pterodactyles with short tails, and quite short in those, like the present specimen, that have the tail long. The metacarpal of the wing finger is always large and robust, while those of the claw bearing digits are usually quite slender. In *Pteranodon*, the second metacarpal is a slender thread of bone throughout most of the length, while the third and fourth are attenuated splint bones, incomplete above.

The phalanges of the three middle digits are quite short, and the terminal ones supported sharp claws. The wing finger has four greatly elongated phalanges, the last being a styloid bone without a claw. This digit is well shown in the right wing represented in Fig. 1, and also in the restoration, given below in Fig. 3.

In the restoration here attempted, the writer has endeavoured to reproduce (1) the parts actually present or clearly indicated in the specimen described, and (2) those which the former seemed to require to complete the outward form in life. The membrane at the base of the tail may have been somewhat less in extent, and the fold of the skin above the fore-arm either more or less developed than here represented, but the facts now known render the outlines here given more than probable. The hands are represented with the palms forward.

The present species appears to be most nearly related to *Rhamphorhynchus Gemmingi*, von Meyer, from the same geological horizon, and near the same locality. That it is quite distinct, however, is shown, aside from the difference in size, by the complete ankylosis of the scapula and coracoid, and by the fifth digit of the hind foot being well developed, and having three phalanges. In the name *Rhamphorhynchus phyllurus*, here proposed for the species, the latter designation refers to the leaf-shaped caudal appendage, which appears to be one of its most characteristic features.

For the long delay in the description of this important European specimen, the writer can only plead *l'embarras des richesses* nearer home. O. C. MARSH

Yale College, New Haven, March 14

THE INSTITUTION OF NAVAL ARCHITECTS

THE annual meetings of the Institution were held this year on the 29th, 30th, and 31st of March. The programme included no less than nineteen papers, not one of which could in any sense be called a stop-gap. It seems a pity that this Institution should hold but one meeting in the year. The time available for reading papers on the three days amounts in all to but twenty hours, which leaves about one hour for the reading and discussion of each paper. It is no exaggeration to say that many of the subjects considered at the recent meetings required a whole day for their adequate discussion, and would have received this allowance of time at any other institution. The true interests of the naval architects are sure to suffer in the long run, if the present policy of cramming so many papers into the short space of time available at the meeting is adhered to. The first paper read, and the only one which dealt directly with ships of war, was by Mr. Samuda. It was an attempt to controvert the arguments made use of by Sir Wm. Armstrong in his recent address to the Institution of Civil Engineers. The address in question has been generally construed into a defence of unarmoured as against iron-clad ships. Sir William Armstrong states that for the cost of one iron-clad we could have three unarmoured ships, each carrying the armament of the iron-clad, and that in a match between the iron-clad and her three supposed antagonists they would probably get the better of it. Mr. Samuda, however, points out, that in fleet fighting, which he supposes will in the future, as in the past, be the principal form of naval combat, this advantage of the many unarmoured ships against the few iron-clads would disappear.

Mr. Samuda further argues that the recent improvements in the construction of the hulls and armour of war ships, due to the introduction of mild steel instead of iron, has at least neutralised the extraordinary improvements made in the guns in the last few years. He also warned his hearers against the disastrous consequences which may be brought about through false economy in naval construction.

The opinion of the meeting as evoked in the discussion was certainly in favour of Mr. Samuda's arguments. Several distinguished naval officers, including Admirals Hornby and De Horsey, and Captain Noel, spoke emphatically of unarmoured war ships as being utterly useless for fighting purposes if opposed by iron-clads. They dwelt on the great value of even a moderate amount of armour, in keeping out projectiles which struck obliquely, and in actual combat but few shots would be likely to strike at right angles. Mr. Burnaby also lent the weight of his great authority to the same view of the question. Upon the whole Mr. Samuda may claim to have considerably modified the effect which was pretty generally produced by Sir William Armstrong's address.

Mr. Dunn, Assistant-Constructor at the Admiralty, read an interesting paper on Modern Merchant Ships. This communication dealt incidentally with the capacity of merchant ships for being converted into cruisers for the protection of other merchant vessels in time of war. This is an important subject, when we remember how miserably inadequate the royal navy is for this purpose. The actual money value of the merchant navy of this country falls little, if at all short, of two hundred millions sterling. If to this sum, we add the value of the freight carried, it will be easy to understand how vulnerable as a nation we are at sea. Mr. Dunn has for some time past been employed by the Admiralty in surveying those vessels, which are intended, should the occasion ever arise, to supplement the regular navy in defending the mercantile marine. The important qualities which a merchant steamer must possess in order to be capable of being converted into a man-of-war are speed, structural strength, considerable relative beam, and powerful steering gear. In all these points it is satisfactory to learn that much progress has been made during the last few years. Taking first the question of speed. Between the years 1875 and 1882, the number of steamers capable of steaming 13 knots and upwards continuously at sea has

increased from twenty-five to sixty-five. In 1875 there were ten vessels capable of steaming over 14 knots, now there are thirty-five, while the highest speeds have been increased from 15 to 17 knots. At the same time the power of these vessels of keeping the seas has been greatly increased through the improvements which have been effected in the economy of the marine engine. There are many steamers which can carry coal enough to steam round the world at a 10 knot speed.

The structural strength of merchant vessels has undergone a remarkable improvement during the last few years, thanks to the increased attention which has been paid to their longitudinal strength, and also to the introduction of steel as a material of construction and of cellular as double bottoms. Doubts have been frequently expressed as to the capability of merchant steamers for carrying guns. A direct experiment was made on this point by the Admiralty in 1878, during the height of the Russian scare, by the purchase by the Admiralty of the *Hecla* from Messrs. Harland and Woolf of Belfast. She was armed with five 64-pounders and one 40-pounder, mounted on truck carriages, and has been in commission ever since, and most favourably reported on. As another example we may mention the case of an Irish cattle-boat which was purchased by the Chilians and armed with an 11-ton gun, and which was employed in the bombardment of the Peruvian ports.

Another most important point in considering the question of the structural strength of these steamers is the question of subdivision by water-tight bulkheads. There has been a strange apathy on this subject till very recently in the mercantile marine. Lloyd's rules insisted on the introduction of four bulkheads, viz. one at each end of the ship, and one at each end of the machinery space. The compartments into which a ship was thus subdivided were in general so large that if one of them filled the vessel went down. In many long passenger steamers where more numerous bulkheads were introduced, their useful effect was done away with by the doors through them not being water-tight; or occasionally by their heads being below the water-level. It is however some satisfaction to know that all the passenger vessels built during the last three or four years for the principal lines are properly subdivided.

It is a matter for regret that Mr. Dunn's official position prevented him from enlightening his audience as to the exact degree of useful help which we may look for from this auxiliary navy in case of actual need. We are also left without any information as the organisation, if any, which exists for rapidly equipping and manning these vessels whenever their services may be called for. Considering the scare which was produced in this country in 1878, by the attempt made by the Russians to convert a few American merchant steamers of very moderate speed into cruisers of the Alabama type, it seems only reasonable to hope that, by utilising the immense resources of our merchant marine, we may find the means of avoiding such panics in the future.

There were some interesting papers read on the subject of marine engines and boilers. Mr. Kirk, of the firm of Messrs. J. R. Napier and Sons, of Glasgow, read an interesting paper on the triple expansive or compound engines which he has recently fitted to the s.s. *Aberdeen;* and Mr. Parker, Chief Engineer Surveyor to *Lloyd's Register*, followed with a general paper on the subject of triple and double compound engines. Thoughtful students of the steam-engine have for some time recognised the fact that one of the principal sources of waste in engines which use steam expansively, is the variation in temperature of the cylinder, due to the difference between the temperature of the steam at the pressures at which it enters and leaves the cylinder. The greater the difference in these pressures, *i.e.*, the greater the range of expansion, the greater also is the difference between the initial and final temperatures of the steam. The consequence is, that the incoming steam finds the cylinder chilled; a portion of the steam as it enters is condensed, causing a loss of pressure and of useful work. As the steam expands and becomes colder than the surrounding walls of the cylinder, a portion of the condensed steam is re-evaporated towards the end of the stroke, and during the exhaust when it can do no useful work. Thus the cylinder at the commencement of the stroke acts as a condenser, and during the end of the stroke and the exhaust as a boiler. It was to obviate the waste due to the above causes that the compound engine was introduced. In this latter class the steam, instead of being expanded throughout in one cylinder, was allowed to expand partially in a high pressure, and subsequently in a low pressure cylinder. Thus the difference in temperature for each cylinder was halved, and the waste due to condensation proportionately diminished. By degrees, however, the pressures made use of in marine boilers were increased, and consequently the range of temperatures even in compound engines became as great as in the old simple expansive engine using lower pressures. To get over this difficulty Mr. Kirk made use of the triple expansive engine, which is really a compound engine again compounded, the steam being expanded successively in three cylinders. In this way the range of temperature is divided into three parts. In the case of the *Aberdeen* the boiler pressure was 125 lbs. per square inch, and the diameters of the cylinders were respectively 80 in., 45 in., and 70 in., by 4 ft. 6 in. in stroke. During a four hours' trial with Penrikyber Welsh coal, the consumption was found to be only 1·25 lbs. per indicated horse power per hour, from which very satisfactory result we should be led to expect a sea consumption of from 1·5 to 1·6 lbs.

Mr. Milton, of *Lloyd's Register*, read a paper on the influence of Lloyd's Rules on marine boiler construction. This paper was called forth by Mr. Marshall's statement at the Mechanical Engineers' meeting at Newcastle, that "the ordinary marine boiler, encumbered as it is by the regulations of the Board of Trade and of Lloyd's Committee, does not admit of much reduction in the weight of material or of water carred when working." Mr. Milton has endeavoured with considerable success to prove that the above remark, so far at least as it applies to Lloyd's, is far from expressing the truth. He explains very clearly the principles on which Lloyd's base their rules. The most important part of his paper is that in which he attempts to show that Fairbairn's rules, as to the strength of cylinders pressed from without, are very erroneous when applied to flues having the dimensions of those of marine boilers. Mr. Milton does not speak hopefully of the use of locomotive boilers for marine purposes. We trust, for the sake of the country, that his experience may not be confirmed by the Admiralty experiments with the *Polyphemus*, which vessel is, as is well known, entirely fitted with boilers of the locomotive type.

Mr. W. H. White, Chief Constructor at the Admiralty, read a most important paper on the Revision of the Tonnage Laws, which we intend to make the subject of a separate notice. It was followed by two communications from Mr. Martell, Chief Surveyor at Lloyd's, and Mr. W. Rundell, Secretary of the *Liverpool Underwriter Register*, on the subject of Load Line, a topic which for many years past has been the subject of much heated argument. Mr. Martell discusses freely the latest proposals of the Board of Trade, and considers in detail the practical considerations which should determine the load line for vessels of various clasess. He is of opinion that the day has passed for the acceptance by shipowners and builders of any scheme for loading which does not take cognisance of the *form* and other elements of a vessel, in addition to the length, depth, or size. He winds up his paper with the following sentence, which may well be commended to the shipowning community. "I cannot

help feeling that shipowners in their own interests would adopt a wise course by supplying correct data, and otherwise considering the question of framing rules, based on sound principles, which would take cognisance of all the surrounding elements affecting this complex question, and thereby enable rules and tables to be framed which would be accepted as a fair compromise, and equitable and sound reference for the future guidance of all interested in this important subject, and the result of which would, without doubt, tend to diminish the loss of much valuable property and the sacrifice of many human lives."

Messrs. Read and Jenkins, of *Lloyd's Register*, contribute a valuable investigation into the transverse strains of iron ships. This subject was, we believe, first investigated vigorously by Mr. W. John, who read a paper on the same subject in 1877, before the Institution of Naval Architects. The method of treatment pursued by Messrs. Read and Jenkins is too technical to reproduce at length in these pages. After investigating the strains of four steam-vessels, supposed to be docked when loaded with cargo of the density of coal, up to the height of the lowest tier of beams, they conclude with the important observation that the results demonstrate, in an unmistakable manner, how necessary it is to provide additional transverse strengthening in the engine and boiler space in steam-vessels, where the localised weights of the engines and boilers, and the want of support from the deck above, due to the small number of beams, increase the strain of the middle line and bilge.

The most interesting of the remaining papers were two by Mr. T. Harvard Biles, naval architect to Messrs. J. and G. Thompson, of Glasgow, on Progressive Speed Trials, and on the Curves of Stability of Certain Mail Steamers. The former paper was of great practical value to naval architects, as it affords to all the means of carrying out progressive trials with ease and rapidity. Mr. Biles abandons the measured mile trial, because of the inseparable inaccuracies which attended it. These were due to the varying and unknown rate at which the tide flows, and to the impossibility of knowing whether the ship, when she comes on the mile, is running at her proper speed, or is accelerating her own motion. Mr. Biles throws out from the bow of the ship a floating object which is observed as it passes a a set of transverse sights fixed on the ship about one hundred feet from the bow, and again when it passes another pair of sights fixed at a given distance from the first pair. The time occupied in the transit is recorded by an electric apparatus, which also at the same time records seconds automatically, and also the number of revolutions of the engine. The floating object moves with the tide, and therefore the speed of flow of the latter need not be taken into account. By means of this apparatus, builders can measure the true speed at which their vessels are travelling when steaming right ahead, and consequently can derive all the information to be obtained from progressive trials, without resorting to the old-fashioned, tedious system of runs on the measured mile.

We regret that want of space prevents us from noticing the remaining papers read at these meetings, not one of which was deficient in interest.

NEW AND VERY RARE FISH FROM THE MEDITERRANEAN

On a long ichthyological excursion which I undertook by order of the Minister of Public Instruction in November and December last, during which I explored our Adriatic coast from Ancona to Lecce, the Ionian shores from Taranto to Reggio (Calabria), and visited the two seas of Sicily, collecting principally at Messina, Catania, and Palermo; I collected above 2000 specimens of fish, amongst which were many rare species, and several quite new to the ichthyofauna of the Mediterranean. Amongst the latter I may mention a large and perfect specimen of *Molva vulgaris*, found in the market of Catania; this is a North Atlantic species, and has not yet been recorded from the Mediterranean; there has been, it is true, for many years a dried skin specimen in the Genoa University Museum, which was figured in 1864 by Canestrini as *Haloporphyrus lepidion*, and six years afterwards corrected by the same author as *Lota vulgaris*. About a year ago Dr. Vinciguerra and myself determined it correctly, but as no data as to its capture had been preserved, we were in considerable doubt as to its being a Mediterranean specimen. At Palermo, where I went after leaving Catania, I found a third Italian specimen of this species. At Messina I collected two specimens of *Scorpæna ustulata*, Lowe, aud a fine specimen of *Umbrina ronchus*, Val., both new, to our fauna. I believe that most of the Madeira species will eventually be found in the Mediterranean, especially off the Sicilian coasts. Messina is a splendid locality for deep-sea or pelagic forms; it appears that during stormy weather, especially from the south-east, many abyssal species are in some way thrown up, and may be found in hundreds floating in the Messina harbour, which stretches like a net or trap across the Straits; such are *Chauliodus*, *Stomias*, *Argyropelecus*, *Microstoma*, *Coccia*, *Maurolicus*, *Gonostoma*, and some ten or twelve species of *Scopelus*. While there last November I secured a fine *Malacocephalus lævis*, and a singular fish of a deep black colour, with small eyes and a naked skin, and a most *abyssal* physiognomy, which is quite new to me, and which I have not yet been able to determine; it may be allied to *Malacosteus*.

I shall close these notes by mentioning the capture of a very strange fish (belonging to the singular *Notacanthi*), which may well be called the *rarest* of fishes. It is a small specimen evidently closely allied to *Notacanthus Rissoanus*, De Filip, but which appears to present some notable differences; I have not yet been able to compare it with the unique and type specimen of *N. Rissoanus*, from Nice, now in the Turin Zoological Museum, and of which no *scientific* description was ever published. My specimen was also caught near Nice in August of last year. *N. Rissoanus* should be generically distinguished from the other known species from which it differs in many essential characters. Lütken and I believe Günther have expressed the same opinion. I should, therefore, propose the name *Paradoxichthys*, and should that term be pre-occupied, the equivalent *Teratichthys*. Should the specimen I have turn out specifically distinct from *P. Rissoanus*, I should like to call it *Paradoxichthys Garibaldianus*, dedicating it to a great Nizzardo and fellow-countryman of Risso.

Florence, March 23 HENRY H. GIGLIOLI

PROF. BARFF'S NEW ANTISEPTIC

In a communication to the Society of Arts, March 29, 1882, a long and interesting paper was read by Prof. Barff on a "New Antiseptic Compound" applicable to the preservation of articles of food.

The compound in question is an ether of boric acid and glycerine of the composition $BO_3C_3H_5$ (the chemical description in the paper is inaccurate), first obtained by Schiff and Becchi (*Compt. Rendus*, 62, p. 397, and *J. pr. chem.*, 98, 184). Experiments made with this substance on various articles of food, both solid and liquid, seem to have yielded very satisfactory results, as far as the preserving action is concerned; but neither in the paper nor in the interesting discussion which followed its reading does it appear that the preserving action is due specially to the compound in question, or to one of its constituents.

That boric acid acts as a preventive of decomposition in organised bodies when present in considerable quantity there is no doubt, but very little is known of its action n

those cases, and practically nothing is known of its action on the human economy, especially when taken in the considerable doses that would be contained in the substances preserved by this proposed compound. So that it seems at least desirable that a little more inquiry should be made as to the physiological action of boron compounds before it is proposed as a wholesale preserver of food stuffs.

Of the other constituent of this compound something more is known. It exists naturally in many articles of food or drink, and its physiological action has been to a considerable extent investigated, and proved to be on the whole quite harmless.

As a preservative against fermentive or bacterial action, it has also been investigated more fully than boric acid.

In a concentrated condition it will resist both ordinary fermentation and the fermentation of various bacteria in a high degree.

As the compound $BO^3C_3H_5$ is decomposed into boric hydrate and glycerine on contact with water, it would scarcely appear that there is any advantage in forming the etherial compound.

It would appear indeed that all the preservative effects claimed for this ether can be obtained by the use of glycerine alone, thus excluding a possible source of danger in the use of a comparatively unknown substance (physiologically) like boric acid (see Kletzinsky, *Dingl. pol. J.*, 171, 370; Kunath, *ibid.*, 193, 439; Wagner, *Jahresb.*, 1868, 523; Fleck, *Dingl. pol. J.*, 196, 487).

NOTES

We are pleased to learn that the Imperial Government has granted a sum of 2500*l.* (1500*l.* this year, and 1000*l.* next), and that the Canadian Government has further voted $4000 for a station for circumpolar observations.

In the discussion on the New Code, on Monday night, in the House of Commons, Sir John Lubbock pointed out several of its weak points as regards the teaching of science. He complained that children of the fourth standard were excluded from specific subjects, and that, as at present worded, children who take class subjects, might never be taught any science at all, as one of them must be English, and another might be history. It would certainly be disappointing, if, after so much thought had been expended in drawing up the New Code, the evident desire of its framers to encourage science teaching should have been defeated. Mr. Maskelyne, Lord G. Hamilton, and others, while supporting Sir John Lubbock's criticisms, pointed out other defects, which, we hope, will have Mr. Mundella's attention. Indeed, he promised to take the suggestions made into consideration, and, we believe, that if he does so seriously, he will see it to be advisable so to frame the regulations as to class and special subjects as to secure that the elements of natural knowledge will have a chance of becoming a regular part of elementary education. The old bugbear attached to the name "elementary science," and to scientific terminology, was alluded to again, but that is a bugbear long ago dissolved, and not worth a moment's consideration; by all who have given the matter any attention, or who have had any experience in teaching, it is admitted that nothing is more interesting to children of all ages than "object lessons," *i.e.* practical instruction in science, and nothing more dreary and unprofitable than "grammar" as usually taught. Our New Code as it stands is a contrast, so far as science is concerned, to the Primary Education Act of France, which has just been promulgated. The Primary Education which is compulsory in France comprises "Moral and civil instruction, reading, writing, geography, history, some notions of law and political economy, the elements of natural, physical, and mathematical science, their applications to agriculture, health, industrial arts, manual labour, and the use of the tools of the principal crafts, the elements of drawing, modelling, and music, gymnastics, for boys military drill, for girls needlework." We shall doubtless reach this standard some day, and one step to it would be to mak attendance at school compulsory on all up to the age of fourtee years.

Dr. Nachtigal, the well-known African explorer, has been appointed German Consul in Tunis.

M. Paul Bert was on Monday elected a Member of the Paris Academy of Sciences, in the Medical Section.

The directors of the Crystal Palace have appointed the following twenty-one British jurymen for the International Electric Exhibition:—Capt. Abney, R.E., F.R.S., Prof. W. Grylls Adams, F.R.S., Major R. F. Armstrong, R.E., Prof. W. E. Ayrton, F.R.S., Mr. Shelford Bidwell, Sir S. Canning, Prof. R. B. Clifton, M.A., F.R.S., Mr. T. R. Crampton, C.E., Mr. Horace Darwin, Prof. G. Carey Foster, F.R.S., Prof. E. Frankland, F.R.S., Capt. Douglas Galton, C.B., F.R.S., Lieut.-Col. W. Haywood, Dr. J. Hopkinson, F.R.S., Prof. D. E. Hughes, F.R.S., Prof. Fleeming Jenkin, F.R.S., Prof. J. W. Keats, Mr. W. H. Preece, F.R.S., Prof. Silvanus Thompson, B.A., D.Sc., Mr. C. E. Spagnoletti, C.E., and Lieut.-Col. Webber, R.E., president, Society of Telegraph Engineers.

The present season seems to have been as remarkably early and open in the Arctic regions as it has been with ourselves. The captain of the French steamer *St. Germain* reports having encountered an ice-floe of vast extent during his last outward voyage across the Atlantic. During the night of February 24-5 the vessel passed through two fields of ice estimated at from two to three miles in width. On the following morning there lay in the course of the ship an immense agglomeration of masses of ice, many of which resembled the *débris* of shattered icebergs, to which no limit could be seen west, north, or south. At this time the vessel was in lat. 46° N., and long. 50° W. The ice was drifting from north to south, and for two hours the ship steamed in a southerly direction along the eastern side of the ice-floe, at full speed, without seeing any opening, its eastern face being perfectly level. Soon after eight o'clock a channel about two miles wide, and running north and south, opened out, which the captain entered, hoping to reach the open sea to the south, but after about an hour's steaming the channel narrowed into a deep strait, when he decided to continue his course slowly and push through the ice, and after three hours perilous navigation, saw open water to the west, which he at last entered in lat. 44° N., and long. 51° W., or about 120 miles to the south, and 60 miles to the west of the point at which the ice-floe was first encountered. Even then the southern limit of the floe could not be seen, although the atmosphere was exceptionally clear at the time. Another report informs us that during the latter half of March quite a hundred icebergs were seen off Cape Race.

From Nottingham is reported the death this week, at the age of seventy-nine years, of Mr. Sydney Smith, the inventor of the steam-pressure gauge, and many other important engineering appliances. Mr. Smith was a native of Derby, and was educated at Repton Grammar School. By the invention of the steam-pressure gauge in 1847 his name became widely known in the engineering world.

The death is announced of Mr. William Menelaus, a gentleman well-known and highly esteemed in connection with the iron and steel industries of this country. He was in the sixty-fourth year of his age. Mr. Menelaus was past president of the Iron and Steel Institute, of which he was one of the first members. He was also the founder of the South Wales Institute of Engineers.

The idea of conducting excavations in the Delta by means of an English fund has now assumed a practical form. The outline of operations as now prepared has received the approval, among others, of the Archbishop of Canterbury, Mr. A. W. Franks, V.P.S.A., Prof. Huxley, F.R.S., Mr. Stanley Lane Poole, the Right Hon. Sir A. H. Layard, G.C.B., Sir John Lubbock, M.P., Prof. Max Müller, Prof. Owen, C.B., Mr. Reginald Stuart Poole, Prof. Sayce, Hon. J. Villiers Stuart, M.P., Mr. W. Spottiswoode, P.R.S., Sir Erasmus Wilson, LL.D., F.R.S. At the first meeting a provisional committee was formed, with Sir Erasmus Wilson as hon. treasurer, Miss Amelia B. Edwards and Mr. Reginald Stuart Poole as hon. secretaries. The society is already in communication with M. Maspero with the object of going to work directly sufficient funds have been obtained.

A work of permanent value has been performed by Prof. F. W. Clarke, of Cincinnati University, in his Recalculations of the Atomic Weights, which has been published by the Smithsonian Institution as Part V. of "The Constants of Nature." Prof. Clarke concludes from his investigation that none of the seeming exceptions to Prout's Law are inexplicable. "Some of them, indeed, carefully investigated, support it strongly. In short, admitting half multiples as legitimate, it is more probable that the few apparent exceptions are due to undetected constant errors, than that the great number of close agreements should be merely accidental. I began this recalculation of the atomic weights with a strong prejudice against Prout's hypothesis, but the facts as they came before me have forced me to give it a very respectful consideration. All chemists must at least admit that the strife over it is not yet ended, and that its opponents cannot thus far claim a perfect victory."

Two interesting discourses, delivered at a recent public *séance* of the Belgian Academy, appear in the *Bulletin* of that body. In one of them M. van Beneden makes the record of a huge whale (*Balænoptera*) captured at Ostend in 1827 (the skeleton of which was exhibited in most of the European capitals, was taken to America, and at length found a final resting-place in St. Petersburg) the starting point for a survey of the large amount of cetological knowledge acquired since that time. In the other discourse, M. Folie laments the backwardness of his country as regards astronomy. "Modern Greece alone, indeed, can advantageously dispute with us the last place in Europe" as regards the history of that science. And it has four centuries of Mussulman tyranny for an excuse. M. Folie cites numerous facts against the view that observatories have mostly sprung out of the interests of navigation. The non-cultivation of astronomy in Belgium in the past he attributes to the country having been long without national independence and a national dynasty. Belgian astronomy only dates in reality from 1834, when the Royal Observatory was founded at Brussels. Astronomy and geodesy "are still taught throughout Belgium, as physics, botany, zoology, physiology, in a word, most of the natural sciences, were taught ten or fifteen years ago, that is, without a laboratory." And "in none of the Belgian universities, except, perhaps, Brussels, is it possible to produce an astronomer or geodesian." M. Folie looks for a speedy rectification of all this. In the outset of his lecture he notices the liberality with which the Government has lately met his proposal to annex an astronomical and geodesic institute to the University of Liège.

The French military authorities lately announced a competition in designs for a soldier's bed. It was stipulated that the bed should be capable of being raised against the wall, and in that position present a small table at which the soldier might eat, write, &c.; the new bed should allow of utilisation of old ones; it should be as cheap as possible, and not need much repair, and it should afford no shelter to bugs (a great pest of the French army). More than a hundred models were sent in, and, after a large elimination about a dozen are on trial. Our contemporary, *La Nature*, in a notice of the more promising designs, gives final preference to a bed planned by Lieut. Bertillon. In it a piece of canvas is stretched within or slightly above a rectangular frame, by means of a rope passing through sixty-four eyelets and round an iron bar parallel with the frame, which supports it. To obviate tearing, the eyelets are encased in pieces of leather attached to the canvas. There is a simple vertical frame at the head, and the support below, at that end, consists of two bars, bent into a shape like that of the lower half of a broad capital D, the vertical part having a board attached, which serves as a table when the bed is tilted up on the curved bars against the wall (an easy operation). The support at the other end is a two-legged stool or short form, on which the soldier can sit at the table. The arrangement seems very convenient and suitable to the object proposed.

Signor Sella (son of the ex-Minister of Italy) ascended the Matterhorn on the 17th ult. with three guides, from the Italian side, and descended at Zermatt. No greater difficulties were encountered than are usually met with in summer.

Shocks of earthquake are reported from Ljubinge (Herzegovina) on March 25, at 6.2 p.m., lasting three seconds; and from Trebinje and Bilek on the same day, at 6 p.m., direction west to east.

Our Paris correspondent inspected a few days ago, at Feil's workshop, the large flint-glass disk which has been cast for the Lick Observatory in California, and purchased by the trustees for 2000*l*. It is now on its way to Clarke's for polishing. Its diameter is 97 centimetres, its thickness 55 centim., its weight 170 kilog. The casting took place in four days, during which eight tons of coals were consumed. The cooling took thirty days. On the optical tests being made the glass was found perfect in all its parts. The crown-glass disk has been cast and is cooling.

The Easter excursion of the Geologists' Association this year is to Battle and Hastings, and will extend over Monday and Tuesday, April 10 and 11.

The seventh annual meeting of the Members of the Sunday Society was held on Friday, March 31, at its rooms, 9 Conduit Street, Mr. Hodgson Pratt presiding. The annual report, which was read by the Hon. Sec., Mr. Mark H. Judge, referred to the work of the Society having been pursued with unabated vigour during the presidency of Mr. Thomas Burt, M.P., and to the growth of public opinion in favour of its objects, and said: "The conviction is evidently gaining ground that the Government cannot much longer delay the extension of its Sunday opening policy to the national museums and galleries in the heart of the metropolis; for since 1854, when the Committee of the House of Commons recommended the opening of places of rational recreation and instruction after the hour of 2 o'clock p.m., both Liberal and Conservative Governments have continued to open on Sundays, the national museums at Kew, Hampton Court, Greenwich, and Dublin, with such results as have not only satisfied Her Majesty's Government, but have had the effect of inducing the Corporations of Birmingham, Manchester and other large towns in the provinces, to open municipal institutions of a similar kind on Sundays. The Sunday Art Exhibitions instituted by the Society had been continued and were being imitated both in London and the provinces. The Right Hon. Viscount Powerscourt, K.P., was unanimously elected president of the Society."

On Saturday afternoon a meeting of the Essex Field Club took place at the Natural History Museum, South Kensington, on the kind invitation of Prof. Richard Owen, F.R.S., who conducted

the members through the Palæontological Galleries, and gave most interesting demonstrations of many of the more remarkable fossils. Dr. Henry Woodward and Prof. Morris were also present, and did all in their power to interest the visitors. Afterwards the Club adjourned to the Exhibition Galleries, Cromwell Road, where General Pitt-Rivers, F.R.S., gave a demonstration of portions of his Anthropological Museum, particularly dwelling upon the developmental ideas underlying the inception and arrangement of that unique collection. The two meetings were entirely successful, considerably over 100 Members and friends being present.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Miss Richards; two Common Marmosets (*Hapale jacchus*) from Brazil, a Silky Hangnest (*Amblyrhampus holosericeus*) from Buenos Ayres, presented by Mr. George Jacobs; a Puffin (*Fratercula arctica*), British, presented by Miss Lane; a Smooth Snake (*Coronella lævis*), British, presented by Mr. Wm. Penney; twenty-five Madeira Snails (*Helix maderensis*), four Undated Snails (*Helix undata*) from Madeira, presented by Mr. George French Angas, C.M.Z.S.; a Diana Monkey (*Cercopithecus diana* ♂), a Talapin Monkey (*Cercopithecus talapin* ♀), a Water Chevrotain (*Hyomoschus aquaticus*) from West Africa, two Green-billed Toucans (*Ramphastos dicolorus*) from Guiana, a Yellow-lored Amazon (*Chrysotis xantholora*) from Central America, two Maguari Storks (*Dissura maguari*), an Orinoco Goose (*Chenalopex jubata*) from South America, a Common Night Heron (*Nycticorax griseus*), European, a —— Monitor (*Monitor*, sp. inc.) from Africa, purchased; two Little Bustards (*Tetrox campestris*), European, deposited; a Radiated Fruit Cuckoo (*Carpococcyx radiatus*, from Sumatra, received on approval.

OUR ASTRONOMICAL COLUMN

COMET 1882 *a*.—The following elements of the comet discovered in America on March 18, have been calculated by Mr. Hind from observations on March 19, 22, and 25, the first telegraphed from America, the two others made at the Observatory of Kiel:—

Perihelion passage 1882, June 12·07195 G.M.T.

	°	′	″	
Longitude of Perihelion	52	6	31	App. Eq.
" ascending node ...	204	59	31	Mar. 22.
Inclination	73	42	44	
Log. perihelion distance	8·870371			

The heliocentric arc described between the extreme observations is only 33′, and the orbit is therefore to be regarded as a first approximation. Another orbit calculated by Dr. Oppenheim from observations on March 19, 23, and 27, gives the epoch of perihelion-passage, June 16·5818 G.M.T., and the log. least distance 9·07186. It is evident, therefore, that the comet will greatly increase in brightness as it draws near to the sun, and we may look for a naked-eye object a fortnight or so before perihelion. The elements, however, will not be well determined in this case, without a much wider extent of observation.

Dr. Oppenheim finds the following places for Berlin midnight. We are indebted for them to Prof. Krueger, the editor of the *Astronomische Nachrichten*:—

	R.A. h. m. s.	Decl. ° ′	Log. distance from Earth.
April 6	18 28 53	+44 43·4	0·2500
7	— 31 14	45 29·4	
8	— 33 41	46 16·2	
9	— 36 13	47 3·9	
10	— 38 50	47 52·5	0·2323
11	— 41 32	48 42·0	
12	— 44 21	49 32·4	
13	— 47 16	50 23·6	
14	— 50 19	+51 15·7	0·2134

The mean of the above perihelion-distances is less than a tenth of the mean distance of the earth from the sun, and comparatively few comets out of the number calculated have approached the sun so closely; indeed, between the commencement of the seventeenth century and the present time we find only nine or ten cases that can be relied upon, in upwards of two hundred and twenty which have been computed.

VARIABLE STARS.—Amongst the objects of this class now in a favourable position for observation is one observed on the meridian at Bonn in May, 1864, and rated 9·0; its position for 1855·0 is in R.A. 13h. 22m. 58·1s., N.P.D. 98° 48′ 54″. It was 8·5 on April 16, 1855, 9·5 on April 30, 1853, and is entered 10m. on Chacornac's Chart, No. 41; on one occasion previous to 1853, it had been noted 8m. On April 5, 1874, it was a faint 9m. It was not observed either by Lalande or Bessel. It is 9m. on Bremicker's chart of the Berlin series. An eighth-magnitude (Santini calls it a sixth) follows about 10′ to the south.

Mira Ceti attains a maximum on May 23. A minimum of S Cancri occurs on April 14, at 9h. 9m. G.M.T.

GEOGRAPHICAL NOTES

THE following papers will be read at the German "Geographentag" which will meet at Halle on April 11–14:—On some scientific results of the voyage of the *Gazelle*, particularly from a zoogeographical point of view, by Prof. Studer (Berne); on the progress of our knowledge of Sumatra, by Prof. Kan (Amsterdam); on the alleged influence of the earth's rotation upon the formation of river-beds, by Prof. Zöppritz (Königsberg); on the colonies of Germans and their neighbours in Western Europe, by Herr Meitzen (Berlin); on the historical development of geographical instruction, by Dr. Kropatschek (Brandenburg); on the treatment of subjects relating to conveyance in geographical instruction, by Prof. Paulitschke (Vienna); on the introduction of metrical measures in geographical instruction, by Prof. Wagner (Gottingen); on the relation between anthropology and ethnology, by Prof. Gerland (Strassburg); on the ethnological conditions of Northern Africa, by Dr. Nachtigal (Berlin); on the Polar question, by Prof. Neumayer (Hamburg); on the geographical distribution of Alpine lakes, by Prof. Credner (Greifswald); on the true definition of the development of coasts, by Prof. Günther (Ansbach); on geographical instruction in its relation to natural sciences, by Prof. Schwalbe (Berlin); on the Guldberg-Mohn theory of horizontal air currents, by Prof. Overbeck (Halle); on the systematic furtherance of the scientific topography of Germany, by Herr Lehmann (Halle). The meeting will be combined with a geographical exhibition.

WITH the sixth part of the volume for 1881 of the *Zeitschrift* of the Berlin Geographical Society we have the usual exhaustive Catalogue of geographical literature for the year, including works and papers in all departments of geography, systematically arranged, and covering about 150 pages. No such complete list is to be found anywhere else. Dr. Konrad Ganzenmüller has a paper in this number on the Climate, Flora, and Fauna of the Central Range of the North-West Himalayas. The first part of the *Zeitschrift* for the present year contains papers by Dr. Theo. Fischer, on the Italian Sea-Chart and Maps of the Middle Ages; on the Sierra of Cordoba, by Dr. Wien; on the Antarctic Flora compared with the Palæozoic, by Dr. Joh. Palacky; and on the Cartography of Bolivia, by Dr. R. Kiepert. No. 2 of the *Verhandlungen* of the Society for 1882 contains a long lecture by Herr Buchner on his three years' exploration in South-West Africa.

THE March number of *Petermann's Mittheilungen* contains an account, by Mr. Knipping, of a recent journey through the central mountainous part of the chief island of Japan; a paper on Capt. Gallieni's mission to the Upper Niger, 1880-81; an analysis, by Prof. Zöppritz, of Mr. Stanley's thermo-barometric observations on his journey across Africa; and a necrology for the year 1881.

THERE have been several books recently published on Manitoba, to which, at present, there is a great rush of emigrants. As a rule, such books give only the bright side of the emigrant's life and prospects in the colony, and it is difficult to get a perfectly trustworthy account of what the emigrant may expect. Two Manitoba books are before us: one by the Rev. Prof. Bryce, of Manitoba College—for education has been well provided for in Winnipeg already—is mainly historical, giving pretty full details of the Earl of Selkirk's attempts at settlement. Messrs. S. Low and Co. are the publishers. The other modest

little volume ("A Year in Manitoba, 1880-81") is published by Messrs. W. and R. Chambers, and contains a full and concise statement of the experience of an officer and his sons on a small farm which they took, about ten miles from Winnipeg. There were not a few hardships certainly, and these are clearly brought out; but the other side is quite as clearly and fairly stated, with a considerable balance in its favour. For any one contemplating emigration to the Canadian North-west, this is the book to get.

BESIDES Mr. O'Neill's paper on his three months' journey inland from Mozambique, the April *Proceedings* of the Geographical Society contain a *résumé* of the information just laid before Parliament on the subject of the Russo-Persian frontier east of the Caspian, accompanied by a map, which can only pretend to reproduce the Russian view of the question. The other paper describes the journey of a Russian officer from Geoktepeh to the Khivan oasis, and is a translation from the Russian. Perhaps the most notable matter in the geographical news is the treaty which M. de Brazza imposed on the native chiefs at Stanley Pool, and by which they undertook to admit none but Frenchmen; some late news is also given respecting Dr. Junker's journey in Central Africa, and Mr. J. M. Schuver's progress to the south-west of Abyssinia. We are glad to see, too, that the international polar meteorological expeditions are not neglected, some very interesting information being furnished respecting those of the Danes to G dshaab, in West Greenland, and of the Dutch to the mouth of the Yenissei. A note is also devoted to the recent Danish explorations at Mear, the Jacobshavn fjord. The French Geographical Society's meetings are very fully reported, as, indeed, they generally are.

A NEW Geographical Society was formed last month at Greifswald, in Pomerania.

A CORRESPONDENT points out, in reference to Dr. Rae's correction of last week, that a gold medal *was* awarded to Nain Singh in 1877, as will be found by reference to the *Journal* for that year, or in the *Proceedings* (old series), vol. xxi. A gold watch had previously been awarded to Nain Singh in 1868, for his route-survey from Lake Mansarowar to Lhasa.

MR. R. ARTHINGTON, of Leeds, who is well-known as the munificent benefactor of African missions, has just presented to the Baptist Society a further sum of 1000*l*. towards the cost of building a steamer for the Upper Congo.

THE Constantine gold medal of the Russian Geographical Society was not awarded this year; the medal of Count Lütke was awarded to Major-General Ernfeldt and Col. Lebedeff, for their geodetical and topographical work in the Balkan Peninsula; the great gold medal of the Ethnographical Section was awarded to M. Potanin for his explorations in North-Western Mongolia; that of the Statistical Section to M. Romanoff for his work on emigration from the Government of Vyatka. The small gold medals were awarded to the astronomer, F. F. Schwartz, the well known explorer of Eastern Siberia, for his determinations of positions in Turkestan and Central Asia; to M. Domojiroff, for anemometrical observations on board of ships; to M. Malakhoff, for ethnographical explorations on the Ural; and to M. Yadrintseff, for his work, "Travels in Western Siberia and on the Altai." Silver medals were awarded to Mydame L. Poltoratzkaya, for her album of photographs from Western Siberia; to M. Lakhmæyer, for photographs of Caucasus and Ural; to M. Kalitin, for maps of the route between Khiva and Akhal-Teke; to M. Ivanoff, for explorations of the Zerafshan glacier; to M. Agapitoff, for explorations of the black earth and loess, in the Government of Irkutsk; to M. Roubach, for meteorological observations on the island of Oesel; to M. Zagursky, for his works on the Caucasian languages and his biography of the well-known explorer of these languages, R. K. Uslar; and to MM. Stevanovsky and Rudinsky, for collections of Russian songs.

THE last number of the *Izvestia* of the Russian Geographical Society contains, among other interesting materials, two lists of points whose latitudes and longitudes were determined by the indefatigable explorer of Eastern Siberia and Turkestan, F. F. Schwartz, the Dorpat astronomer, during the years 1879 and 1880. After having determined, in 1879, the positions of ten points in Eastern Turkestan, he now publishes a list of twenty-four points in the Kulja territory, from Kulja along the two long valleys of the Kash and of the Kunghes rivers, which cross this territory from east to west, that of Kunghes having been explored to its source, and the most eastern point reached by M. Schwartz being the Narat Pass, at the south-eastern frontier of the Kulja territory. A series of determinations between Vernyi and the Narat Pass, along the Tekes river, were made during the same year. The numerous magnetic observations made by M. Schwartz during these two journeys, will be published as soon as calculated.

MATTER AND MAGNETO-ELECTRIC ACTION[1]

THE late Prof. Clerk Maxwell, in his work on "Electricity and Magnetism" (vol. ii. p. 146), lays down as a principle that "the mechanical force which urges a conductor carrying a current across the lines of magnetic force, acts, not on the electric current, but on the conductor which carries it. If the conductor be a rotating disk or a fluid it will move in obedience to this force, and this motion may or may not be accompanied with a change of position of the electric current which it carries. But if the current itself be free to choose any path through a fixed solid conductor or a network of wires, then, when a constant magnetic force is made to act on the system, the path of the current through the conductors is not permanently altered, but after certain transient phenomena, called induction currents, have subsided, the distribution of the current will be found to be the same as if no magnetic force were in action. The only force which acts on electric currents is electromotive force, which must be distinguished from the mechanical force which is the subject of this chapter."

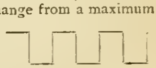
In the investigation on electric discharges, on which Mr. Moulton and myself have been long engaged, we have met with some phenomena of which the principle above enunciated affords the best, if not the only, explanation. But whether they be regarded as facts arising out of that investigation, or as experimental illustrations of a principle laid down by so great a master of the subject as Prof. Clerk Maxwell, I have ventured to hope that they may possess sufficient interest to form the subject of my present discourse.

The experiments to which I refer, and of which I now propose to offer a summary, depend largely upon a special method of exciting an induction-coil. This method was described in two papers, published in the *Philosophical Magazine* (November, 1879), and in the *Proceedings* of the Royal Society (vol. xxx. p. 173), respectively; but as its use appears to be still mainly confined to my own laboratory, and to that of the Royal Institution, I will, with your permission, devote a short time to a description of it, and to an exhibition of its general effects.

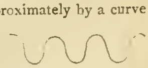
The method consists in connecting the primary circuit directly with a dynamo- or magneto-machine giving alternate currents. In the present case, I use one of M. de Meritens' excellent machines driven by an Otto gas-engine. The speed of the de Meritens machine, so driven, is about 1100 revolutions per minute.

In this arrangement the currents in the secondary are of course alternately in one direction and in the other, and equal in strength; so that the discharge appears to the eye, during the working of the machine, to be the same at both terminals.

The currents in the primary are also alternately in one direction and in the other, and consequently, at each alternation, their value passes through zero. But they differ from those delivered in the primary coil with a direct current and contact breaker in an important particular, namely, that while the latter, at breaking, fall suddenly from their full strength to zero, and then recommence with equal suddenness, the former undergo a gradual although very rapid change from a maximum in one direction through zero to a maximum in the opposite direction. The ordinary currents with a contact breaker would be represented by a figure of this kind,



while those from the alternate machine approximately by a curve of the following form. The rise and fall of the latter are, however, sufficiently rapid to induce currents of high tension and of great quantity in the secondary.



From these considerations it follows: first, that as the machine effects its own variations in the primary current, no contact breaker is necessary; secondly, that as there is no sudden rupture of current, there is no tendency in the extra current to produce a spark or any of the inconveniences due to an abrupt opening of the circuit, and consequently that the condenser

[1] Lecture at the Royal Institution, March 31, by Dr W. Spottiswoode, Pres.R S.

may be dispensed with; thirdly, that the variations in the primary, and consequently the strength and period of delivery of the secondary currents is perfectly regular; fourthly, that the strength of the currents in the secondary is very great. With a 26-inch coil by Apps I have obtained a spark about 7 inches in length, of the full thickness of an ordinary cedar pencil. But for a spark of thickness comparable at least with this, and of 2 inches in length, an ordinary 4-inch coil is sufficient.

Owing to the double currents, the appearance of the discharge is that of a bright point at each terminal, and a tongue of the yellow flame, such as is usually seen with thick sparks from a large coil, issuing from each. This torrent of flame (which, owing to the rapidity with which the currents are delivered by the machine, is apparently continuous) may be maintained for any length of time. The sparks resemble those given by my great coil (exhibited in this theatre on Friday, April 13, 1877, and described in the *Philosophical Magazine*, 1877, vol. iii. p. 30) with a large battery-power and with a mercury break; but with that instrument it is doubtful whether such thick sparks could be produced at short intervals, or in a rapid shower, as in this case.

In order to contrast the effects of the two methods, I will excite the coil, first with a battery, and secondly with the alternating machine. You will notice that with the battery we can obtain either long, bright, and thin sparks, or short and comparatively thick discharges; but, unless the latter are made very short, they occur only at comparatively long and even perceptible intervals of time. On the other hand, with the alternate machine, although the method does not lend itself so readily to the production of long and bright sparks, we can produce a perfect torrent of discharges more rapid and more voluminous than by any other means yet devised. Long bright sparks can, however, be obtained by interrupting the flow of the currents from the machine, and by allowing only single currents to pass at comparatively long intervals. It may be interesting to know that the number of currents given out by the machine, and consequently the number of discharges issuing from the coil, is no less than 35,200, that is, 17,600 in each direction, per minute. The number may be determined by the pitch of the note which always accompanies the action of an alternate machine.

A comparison of the two methods may also be made when a Leyden jar is used as a secondary condenser. This application of the jar is well known as a valuable aid in spectroscopic research; and the employment of the alternating machine so materially heightens the effects that, judging from some experiments made in the presence of Mr. Lockyer, and from others of a different character in the presence of Prof. Dewar, I am led to hope from it a further extension of our knowledge in this direction. In order that you may form, at all events, some rough idea of the nature of such discharges, I venture, at the risk of causing some temporary inconvenience from the noise, to project the spectrum of this spark.

I will detain you with only one more instance of comparison. The ordinary effect of an induction coil in illuminating vacuum tubes is well known. The result is usually rather unsteady. Several instruments have been devised to obviate this inconvenience, *e.g.* the rapid breakers described in the *Proceedings* of the Royal Society (vol. xxiii. p. 455, and vol. xxv. p. 547), or the break called the "Trembleur" of Marcel Deprez (see *Comptes rendus*, 1881, I. Semestre, p. 1283). The use of the alternating machine, however, not only gives all the regularity in period, and uniformity in current, aimed at in these instruments, but also at the same time supplies currents of great strength. The result is a discharge of great brilliancy and steadiness, and it is perhaps not too much to say that the effects are comparable to those obtained with Mr. De La Rue's great chloride of silver battery. The configuration of the discharge produced in this way can also be controlled by a suitable shunt applied to the secondary circuit; for example, one formed by a column of glycerine and water, or the one consisting of a film of plumbago spread upon a slab of slate, constructed by my assistant, Mr. P. Ward, and here exhibited.

One test of the strength of current passing through a tube is the amount of surface of negative terminal, which it will illuminate with a bright glow. I have here a tube with terminals, in the form of rings, each of which would be regarded of ample size for currents obtaided in the ordinary way. These are now all connected together so as to form one grand negative terminal; and it will be found that with the currents from the alternate machine, the whole system is readily illuminated at once.

It should perhaps be here remarked that, while the strength of the secondary currents passing through the tube is partly due directly to the strength of the primary currents from the machine, it is probably also in part due to the rapidity with which the secondary currents follow one another. Owing to the latter circumstance the column of gas maintains a warmer and more conductive condition than would prevail if the inteval between the discharge was longer; and in consequence of this a larger portion of the discharges can make its way through than would otherwise be the case.

Before leaving the instrumental part of my discourse, I desire to bring under your notice a modification of the machine which we have thus far used for producing, by the intervention of the induction coil, currents of high tension. This consists of a machine of the same general construction as the other, but having the armatures wound with a much greater number of convolutions of much finer wire. The result is a machine giving off currents of sufficient tension to effect, by direct action, discharges through vacuum tubes, and even in air. The currents are of course alternate; but by diminishing the size of one of the terminals to a mere point, as well as by other methods described elsewhere, it is possible to shut off the currents in one direction, leaving only those in the other direction to discharge themselves through the tube. I hope on some future occasion to give a fuller account of this remarkable machine, which has only quite recently been completed.

Returning to the discharge in air, it will be noticed that when the terminals are set horizontally, the torrent of thick discharges assumes the appearance of a flame, which takes the form of an inverted V. This is the result of convection currents due to the heat given off by the discharges themselves. The discharges are by their nature, as it were, fixed at each end, but within the limits of discharging distance, free to move about and to extend themselves in space, especially in their central part. Further, it may be observed that the length of the spark which can be maintained is greater than that over which it will leap in the first instance. The explanation of this is to be sought in the fact, that when the sparks follow very rapidly in succession, the whole path of each discharge remains so far in a heated state, as to assist the passage of the next; and, further, that in the middle part of the discharge or apex of the Λ, where the heat is greatest, the heat prevails to such an extent as to render a portion of the path highly conductive. This may be illustrated by holding a gas jet near the path of the discharge. The flames will then leap to the two ends of the jet, which will perform the part of a conductor; and the real length of the discharge will be that traversed from terminal to terminal, minus the length of the intervening flame. The permanently heated part of the flame will act in the same manner in extending the effective length of the discharge.

The discharge which we are now examining is not homogeneous throughout, but consists of more than one layer. The flame, which, from the fact of its forming the outer sheath of the discharge, is the most prominent feature, consists mainly of heated but solid particles emanating from the terminals. That this is the case may be inferred in a general way from the colours which the flame assumes when different substances are placed upon the terminals; for example, lithium or sodium. The spectrum of the flame appears to be always continuous. A convenient substance to affix to the terminals is boron glass, on account of the brilliancy to which it gives rise in the discharge; this will enable us to project the phenomenon. Within this sheath of flame, the discharge consists of the pink light characteristic of air, and in the centre of all the true bright spark. There is reason to think that, under certain circumstances, there are more layers to be seen; but the above division is sufficient for our present purpose. In this somewhat complicated structure, the pink light corresponds to the arc, and the flame to a similar accompaniment which is seen playing about the upper carbon in electric lamps when a current of great strength is used.

From this account of the methods here employed I now turn to the main question. In the investigation, to which allusion was made at the beginning of this lecture, it occurred to us that an examination of the effects of a magnetic field on discharges of this character through air or other gases at atmospheric pressure, and a comparison with those obtained at lower pressures, might throw some fresh light on the nature of electrical discharges in general. It is these phenomena to which I now propose to ask your attention.

When the discharge, originally in the form of a vertical spindle, is submitted to the action of a magnet whose poles are horizontal, it spreads out into two nearly semicircular disks, one due to the discharges in one direction, and the other to those in the opposite direction. As the magnetism is strengthened, the flame retreats towards the edge of the disks, and ultimately disappears. The disk then consists mainly of the pink discharge; but with a still stronger magnetic field, it is traversed at intervals by bright semicircular sparks at various distances from the centre. In every case, bright sparks pass directly between the terminals at the opening of each separate discharge.

In order further to disentangle the parts of this phenomenon, recourse was had in the original experiments to a revolving mirror. The light in the disks is insufficient to allow of a projection of the effects, but the accompanying diagrams represent the appearances seen in the mirror. Fig. 1 shows the arrangement of the terminals and the magnetic poles; Fig. 2 the appearance of the discharges in a plane at right angles to that of Fig. 1; Fig. 3 the appearance of three successive discharges (in the same direction) with a weak magnetic field and a slowly revolving mirror; Fig. 4 the same, with a slightly more rapid rate of revolution; Fig. 5 a single discharge, with a

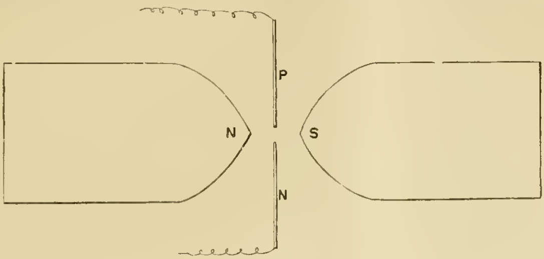


FIG. 1.

stronger field and greater speed of mirror; Fig. 6 a single discharge in a strong field, with a still greater speed of mirror. It should be mentioned, that in all these figures the images to the left are to be regarded as anterior to those on the right, and that they represent various phases of the left-hand discharge in Fig. 2.

If, however, we observe the right-hand discharges with a mirror revolving in the same direction as before, it is clear that the actual curvature of the discharge will be turned in the opposite direction (with reference to the motion of the mirror) to that

FIG. 2.

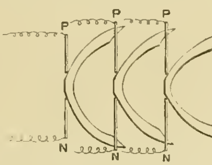


FIG. 3.

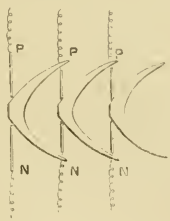


FIG. 4.

in the case of the left-hand discharges. The consequence will be, that the appearance in the mirror, when the rate of revolution is not too great, will be something like Fig. 7, instead of Fig. 6. As the speed of the mirror is increased, the convexity will diminish, and ultimately be replaced by a concavity of the same kind, although not so marked, as that in the case of the left-hand discharges.

These diagrams show that each coil discharge commences with a bright spark passing directly between the terminals; that this spark is, in general, followed by the pink light or arc discharge, which passes first in the immediate neighbourhood of the initial spark, and gradually extends like an elastic string in semicircular loops outwards; and that the flame proper is a phenomenon attendant on the close of the entire discharge. It should be added that observations with a mirror revolving on a horizontal axis, and with a horizontal slit in front of the discharge, show that the disk is not simultaneously illuminated throughout, but that it is a locus of a curvilinear discharge which moves outwards and expands in its dimensions from the centre.

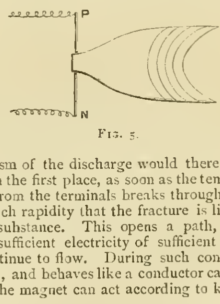


FIG. 5.

The mechanism of the discharge would therefore seem to be as follows:—In the first place, as soon as the tension is sufficient, the electricity from the terminals breaks through the intervening air, but with such rapidity that the fracture is like that of glass, or other rigid substance. This opens a path, along which, if there remains sufficient electricity of sufficient tension, the discharge will continue to flow. During such continuance the gas becomes heated, and behaves like a conductor carrying a current, and upon this the magnet can act according to known laws. As

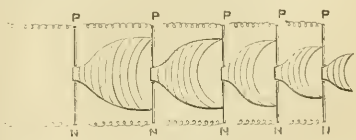


FIG. 6.

long as the electricity continues to flow, the heat will at each moment determine the easiest, although not the shortest path for its subsequent passage. In this way the gas, which acts at one moment as the conductor of the discharge, and at the next as the path for it, will be carried further and further out, until the supply of the electricity from the coil fails, and the whole discharge ceases. We are, in fact, led by these experiments to the conclusion that it is the gas in the act of carrying the current, and

not the current moving freely in the gaseous space, upon which the magnet acts.

This explanation of the magnetic displacement of a discharge receives strong support from the phenomena represented in Figs. 5, 6, and 7. The successive bright lines there shown must be due to successive falls and revivals of tension within a single coil discharge. The existence of such alternations in coil discharges of large quantity is otherwise known. When the fall in temperature is such that the conductivity of the gas is insufficient to maintain the arc, the discharge can make its way through the air only by a fresh rent of the same kind as the first fracture. But how can this be reconciled with the fact that the tension can never reach its original degree, and must, on the whole, be gradually falling, and that, in addition, the paths represented by these various sparks are successively longer and longer? The answer to this question is to be found plainly written in the phenomena themselves. Any irregularity in one of these bright lines is always to be found accurately repeated in all of the same series. Now, it is scarcely to be conceived that, at successive instants of time and in different portions of space, irregularities in the discharge itself, and in the distribution of the gas, so precisely the same, would constantly and for certain recur; and we are therefore driven to the conclusion, that it is the same portion of gas which at first occupied the centre of the field, with its same, yet unhealed rent, which is moved outward under the action of the magnet. If this be so, we have in this repetition of minute details, nothing more than what would necessarily follow from successive reopenings of the weak parts of the gas, which would be surely found out by the electricity in its struggle to pass.

The view here taken of the material character of the luminous discharge is further borne out by the fact that the spindle of light is capable of being diverted by a blast of air. When the blast is gentle, the discharge becomes curvilinear, approximately semicircular, and the yellow flame may be seen playing about the outer edge in the same way as in a weak magnetic field. When the blast is stronger, the sheet of light becomes irregular in form, and it is traversed by a series of bright lines, all of which follow, even in their minute details, the configuration of

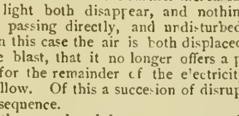


FIG. 7.

the sheet. The analogy between this and the phenomena produced in a strong magnetic field needs no further remark. If the strength of the blast be still further increased, the flame and the sheet of light both disappear, and nothing remains but bright sparks passing directly, and undisturbed, between the terminals. In this case the air is both displaced and cooled so rapidly by the blast, that it no longer offers a practicable conductive path for the remainder of the electricity, coming from the coil, to follow. Of this a succession of disruptive sparks is a necessary consequence.

The effect thus produced by a very strong blast is in fact similar to that observed when a jar is used as a secondary condenser. In this case the electricity, instead of flowing gradually from the coil, passes in one or more instantaneous discharges with finite intervals of time between them. Each of these has to break its way through the air; and that done, it ceases. Hence, neither a magnet, nor a blast of air will have any effect in diverting such a discharge.

As a last stage of the phenomena, it may be mentioned that, if the interval between the terminals be near the limit of striking distance, either a blast of air, or the setting up of a magnetic field, will alike extinguish the discharge.

Our experiments have been thus far carried on in air at atmospheric pressure; but there is nothing in this pressure which is essential to them or to the conclusions to which we have been led. We may therefore repeat them in air, or any other gaseous medium, at any pressure we please. This consideration leads us into the region (so fertile in an experimental point of view) of discharges in vacuum tubes.

Commencing with a tube of moderate diameter and of very slight exhaustion, we can at once recognise our former phenomena slightly changed. Proceeding to another tube, of larger diameter and of moderate exhaustion, and placing it axially or equatorially in a magnetic field, we see not only that the discharge (or rather the conductor carrying it) is displaced, but also that the displaced part is spread out into a sheet or ribbon, showing that the discharge is affected gradually, exactly in the same way as was found in the open air.

When the exhaustion is carried further, the phenomena become rather more complicated. At an early stage there is a distinct separation between the "negative glow" and the rest of the luminous column; and at a more advanced stage the column itself is broken into separate luminosities or striæ. When this is the case, it is usually said that the negative glow follows the lines of magnetic force, while the luminous column distributes itself according to Ampère's law.

It will, however, be found that when completely analysed the action of the magnet upon the striæ, taken individually, is the same as that upon the negative glow, due allowance being made for the differences in local circumstances subsisting between the one and the other. We have elsewhere shown that the negative glow is in reality as truly a stria as any other individual member of the luminous column; but with this difference, that it is anchored to, and dependent for its form on, a rigid metallic terminal, whereas each of the others is dependent on the variable form and position of the stria immediately next in order, reckoning from the negative end of the tube. The action of a magnet in throwing the negative glow into a sheet of light, which is the locus of the lines of force passing through the terminal, and which consequently varies with the position of the tube in the field, is a phenomenon so well known that we need repeat only a single experiment by way of reminder.

Although it is not altogether so easy to show that the other striæ are directly affected by a magnetic field in the same way as is the anchored stria, we may still satisfy ourselves that it is the fact, from the consideration that when the striæ are well developed and the magnetic field is strong, it is quite possible to form a magnetic arch at any part of the column. In this experiment it will be noticed that for the formation of the arch in mid-column it is necessary that both poles of the magnet should act upon one and the same stria. This, in fact, means that the pole nearest the negative end anchors the stria, and thereby brings it into conditions similar to those of the negative glow. When this is effected the two exhibit similar modifications in the magnetic field.

In support of this view, we may adduce another and quite independent method of anchoring a stria, and of thereby producing a magnetic arch elsewhere than at the negative terminal. It was noticed by Goldstein and others that if the negative terminal of a tube be enveloped by an insulating surface of any form pierced with a number of holes or if a diaphragm similarly pierced be placed anywhere in the tube, that the pierced surface will act as a negative terminal. He also found that the finer and closer the holes, the more complete the resemblance to the action of a negative terminal. But even when the substance is metallic, and when the holes are neither very small nor very numerous, a perforated diaphragm will so far act like a negative terminal as to serve as a point of departure of a stria. There is, however, this difference, that the blank space immediately adjoining the diaphragm, as it is usually called, is not generally so large as that at the true terminal; and the striæ thus artificially formed always lie close up to the holes. The diaphragm, in fact, anchors the stria, and renders it susceptible of the same magnetic effect as was shown in the cases studied before.

The action of a diaphragm in a magnetic field gives rise to many other interesting and remarkable results; some of which would further illustrate the views now submitted for your consideration. But these must be reserved for another occasion.

In the foregoing experiments, and in the remarks which have accompanied them, I have endeavoured to illustrate, by reference to gaseous media, the principle enunciated at the outset, that in the displacement of the discharge in a magnetic field, the subject of the magnetic action is the material substance or medium which conveys the discharge. I have shown also that, even when the discharge takes place in media so attenuated as to produce the phenomena of striæ, the same principle applies not only to the discharge as a whole, but also to each component stria or unit; and, lastly, that the apparent diversity of effect on the various striæ is due to local circumstances, and not to any fundamental difference between the "negative glow" and the members of the "positive column."

Seeing now that the magnetic displacement of the luminous discharge means displacement of the matter in a luminous con-

dition, and that a crowding of such luminous matter involves an increase of luminosity, may we not infer with a high degree of probability that the striæ are themselves aggregations of matter, and that the dark spaces between them are comparatively vacuous.

It is true that such a view of the case would seem to imply that, in gaseous media, the better the vacuum the more easily can the electricity pass; and that this might at first sight appear to be at variance with the known fact that the resistance of a tube decreases with the pressure until a minimum, determinate for each kind of gas, and then increases. But it has been suggested by Edlund (*Annales de Chemie et de Physique*, 1881, tom. iii. p. 199) that the resistance of a tube may really consist of two parts, first, that due to the passage of the electricity through the gas itself, and, secondly, that due to its passage from the terminals to the gas; and also that the former decreases, while the latter increases, as the pressure is lowered. On this supposition, the observed phenomena may be explained, without assigning any limit to the facility with which electricity may traverse the most vacuous space.

We may even carry the suggestion of a resistance of the second kind a little further, and suppose that there is a resistance due to the passage of electricity from a medium of one density to that of another, or from layer to layer of different degrees of pressure. And from this point of view, we may regard the striæ as expressions of resistance due to the varying pressure in different parts of the tube. Into the question, whence this variation of pressure, I am not at present prepared to enter; it must suffice for this evening, to have shown that the conclusions which we have drawn from our experiments, are not in disaccordance with other known phenomena of the electrical discharge.

The warning hand of time bids me not to prolong my discussion of the subject. But before closing, I would point out that these laboratory experiments are not unsuggestive in reference to larger questions. It has long been, and still is, a disputed question whether a display of the aurora borealis ever takes place at any considerable elevation above the earth's surface. On the one hand, observations are cited giving a not unfrequent elevation of nearly 200 miles; while on the other, experiments with vacuum tubes appear to limit the range to less than forty miles. The observation is perhaps a doubtful one at best; it is not easy to fix the position of so faint and flickering a phenomenon, and it is perhaps even more difficult to identify a particular phase of it when seen from two distant positions. But the recorded data are still entitled to some consideration, especially if it has been shown that the evidence furnished by vacuum tubes is not conclusive against the higher estimate.

It would be very pleasant, if, wafted by the breezes of scientific imagination, we were to set full sail, and navigate our bark into still more distant space. And, indeed, we are under no slight obligations to those strong minds and courageous spirits who thus adventure themselves out beyond well-known waters; for the treasures which they bring back from every such voyage are both valuable and strange, and they set men thinking on new and untrodden lines. But lest, less fortunate than my neighbours in any such venture, I should fail to fall in with a returning current, capable of recovering my expended energy, and of restoring myself to *terra firma*, I must here pause. It is, however, said, that in the mind of every one, even the most philosophic, there is a tender part; and therefore I must ask your indulgence, if, while resolutely turning my back on physical speculations, I still return for a moment to my first love, mathematical contemplation. For, in the region which we have been considering, namely, the magnetic field, explored and represented by its electric action, we seem to have entered upon a world which Riemann might have longed to see, a world wherein Lobatcheffski and Beltrami might have enjoyed the full fruition of realised ideas, and where even Clifford might have found abundant scope for the exercise of his inexhaustible powers of imagination and of thought.

FLORA OF NEW SOUTH WALES IN ITS GEOLOGICAL ASPECT

THIS, the oldest of the Australian settlements, may have its area grouped as follows:—(1) That of the sandstones or poor country represented by the Proteads and Epacrids; (2) the eastern slopes of coast range represented by the tree-nettles and the palms; (3) the cold mountain shrubs represented by sassafras, tree ferns, and myrtles; and (4) the interior plains represented by Chenopods and Compositæ. It may be wondered how the distribution of the vegetation has originated. That the Australian continent has risen slowly, is gathered from numerous proofs, among others the very apparent one of the strata exhibiting preponderately a horizontal plane. It may further be inferred that in its uplifting, the outer rim of the continent was slightly more elevated than the interior. This taken into consideration along with what doubtless at one time existed, namely, a great inland sea, abundance of marshes and mud, and a once probable greater rainfall, and particularly the latter, though one and all may have contributed to the present physical features, and consequently plant life. Another interrogatory arises, viz. Whence the coal-seams? As to these, there is some likelihood they are the remains of vegetation borne hence from a now sunken continent eastward of Australia; New Zealand, Norfolk, and Howes Island being outliers or now mere island vestiges of the said great land area in the Pacific Ocean.

Of the four local divisions above enumerated, the most typical vegetation of the first is the group Proteaceæ, a very ancient family, extending back to the secondary period of geology, from which time Australia apparently has never been submerged. A point of very considerable importance as bearing on this long-continued stability of the Australian continent may be derived from the remarkable close relationship and insensible gradation of some plants; for instance there is great difficulty in separating species of Eucalypti, Banksias, &c. Thus it may be said none or few of the connecting links have been lost, as must necessarily have been the case had submergence and elevation of the land have occurred.

Many curious problems yet await investigation, such as the fertilisation of the Proteads, including the Styleworts and Goodenia family. Again, have the Epacrids once been a family of trees, wherefrom the living species are but decadent examples? The Casuarineæ, or Beefwod tribe, are undoubtedly an ancient group, and like conifers, flourished in the dawn of life. The second division of the eastern slopes, Palms, and Tree-nettles possibly may have had an Asiatic origin, through the Malayan Archipelago. They appear not to be truly Australian in origin, but themselves only long established colonists. On the contrary, among the third division of the cold mountain scrubs, the Dorophoræ (Sassafras) hold a conspicuous place, and evidently are of Australian derivation. The peculiar vegetation of the interior plains or fourth division, the Chenopods and the Compositæ, are rapidly becoming one of the past, and the small species even now are sensibly giving place to the introduced grasses and weeds. Apart from the groups mentioned as most typical of the four areal divisions in question, as regards the Acacias and Eucalypts, they have the widest distribution and complicated genera. They both appear to be genera at their zenith, having existed long enough to pass into redundant forms, but not long enough to have been exposed to vicissitudes and decline. Their absence from Howe's Island and New Zealand shows they in all likelihood did not belong to the hypothetical submerged continent, nor are they old enough to be found along with the laurel and other remains of the gold drift. (Abstract of a communication by Mr. Robert Fitzgerald, F.L.S., read at the meeting of the Linnean Society, February 2, 1882.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The recent report of the Council of the Senate relative to the proposed Professorship of Animal Morphology, is creditable both to the University and to the Council. We think it desirable to quote some of its paragraphs entire. "The successful and rapid development of biological teaching in Cambridge, so honourable to the reputation of the University, has been formally brought to the notice of the Council. It appears that the classes are now so large that the accommodation provided but a few years ago has already become insufficient, and that plans for extending it are now occupying the attention of the Museums and Lecture-Rooms Syndicate.

"It is well known that one branch of this teaching, viz., that of Animal Morphology, has been created in Cambridge by the efforts of Mr. F. M. Balfour, and that it has grown to its present importance through his ability as a teacher and his scientific reputation.

"The service to the interests of natural science thus rendered

by Mr. Balfour having been so far generously given without any adequate academical recognition, the benefit of its continuance is at present entirely unsecured to the University, and the progress of the department under his direction remains liable to sudden check."

It is recommended that a Professorship of Animal Mythology shall be established, terminable with the tenure of the first Professor; the stipend to be 300*l*. a year; the Professor to be appointed by vote of members of the Senate on the Electoral Roll. The duty of the Professor is defined as "to teach and illustrate the principles of the structure and development of animals, to apply himself to the advancement of the knowledge of those subjects, and to promote their study in the University." The Grace will be proposed on May 11.

From the reports of the natural science examiners in the last Local Examinations, we learn that the Junior Chemistry paper was very feebly answered, many being unable to explain the difference between a chemical compound and a mechanical mixture; but the practical work was satisfactorily done. The senior boys did well in chemistry, though the girls did badly. In heat, there were many failures among the Juniors, with great want of exactness in the definition of important terms: the majority failed to do a very simple calculation concerning the expansion of a solid; the Seniors did better. In Statics and Hydrostatics the papers of the Juniors were unsatisfactory; the answers to one numerical question were mostly confused masses of figures without a single word to serve as a clue to the labyrinth. The Seniors also receive a bad report; the questions involving accurate definition were not either attempted or were poorly done. In Botany the Junior papers were moderately good; there was, however, a tendency to the indiscriminate use of technical terms without a due regard to their meaning. The Seniors in many cases showed complete ignorance of some of the most elementary facts; the description of specimens was especially bad. In zoology both Juniors and Seniors did fairly well; still there was a general absence of diagrams, and little evidence of practical work. One valuable remark of the examiner is that young scholars should not be informed of the erroneous ideas of the older naturalists, even though the errors are pointed out, as unnecessary trouble is thereby given, and confusion is likely to be caused. In Physical Geography, good papers were sent up; but in Geology the majority were altogether unsatisfactory.

The examination for a vacant Sheepshanks Astronomical Exhibition will be held in Lecture Room No. 7, at Trinity College, on Monday, April 24.

The Demonstrator of Comparative Anatomy will take an advanced class for instruction in the Sauropsida next term, beginning April 18.

EDINBURGH.—At the close of his lecture on Friday, 31st ult., Prof. Archibald Geikie was presented with an illuminated address by past and present students of the Geology class in the University of Edinburgh. Mr. John Murray, of the *Challenger* Expedition, presented the address, which was as follows:—

"Sir,—We, your present and former students in the University of Edinburgh, beg to pay you the tribute of a brief farewell. While rejoicing in the honour conferred on you by your appointment as Director-General of the Geological Survey of Great Britain and Ireland, we would record, along with the expression of our most hearty congratulations, our deep sense of the loss which both we and our *Alma Mater* will sustain by your departure. To the distinguished services you have rendered the science in which you have taught us to share your interest and enthusiasm, we will do no more than refer; though we cannot fail to remember with pride how signally you have maintained the reputation of the Scottish School of Geology, and of Edinburgh, its metropolitan seat. We would here simply recall the many happy hours we have spent with you, both in the geological class-room and in the field, and express, for ourselves and for others now scattered over the world, the feelings of gratitude and affection with which your name will ever be regarded. We are, sir, with much respect and affection."

Having read the address, the sentiments of which were warmly applauded, Mr. Murray said that Prof. Geikie would find in it the names of about 140 students, and they expected that a number more would yet be added. They did not intend the address to express all the deep feelings they had towards Professor Geikie, nor did they attempt to say all that one should wish about the admiration in which they held Prof. Geikie as a scientific man and as a teacher. Upon the face of the address were some sketches by one of his present pupils, which might serve to remind him of the instruments with which they had fought, and of some of the battle-fields upon which they had been employed together—engaged in a fight in which the students knew Prof. Geikie had been a most excellent general for them. After mentioning that a casket for the address would be presented at a social gathering to be held in a few weeks thence, Mr. Murray, in name of the past and present pupils of the class, wished the Professor health, strength, success, and distinction in the new sphere of work to which he had been transferred. Prof. Geikie, who was warmly applauded, said there were moments in a man's life when the depth of his emotion was best expressed by silence. Therefore he made no attempt to tell the students how much their kindly feelings always, and this especially hearty outburst, had touched every fibre of his heart. At the close of every session he had been accustomed to look forward to the final day with great depression of spirits. It had always been to him a sad thing to say "good-bye" to the young men with whom he had been brought into such close personal contact during the winter; but this was to be his last adieu to them, and he could hardly trust himself to shape into words the feeling of genuine sorrow with which he left that class-room. Eleven years ago he began the work of that class. The Chair of Geology in the University was founded by the munificence of Sir Roderick Murchison, who was struck down by illness before the arrangements for the foundation were completed, and he believed it was largely due to the present Parliamentary representative of the University, Dr. Lyon Playfair, that these arrangements were finally carried out. As the students had said in the address, his aspirations had been very strong towards reviving, as far as in him lay, the fame of the Scottish School of Geology. No one could be more sensible than he was, of how far he had fallen short of the aspirations with which he began his work. But although he did not for a moment attempt to justify his failures, he should try to show them how difficult his task had sometimes been. When he entered on his duties, there was not one diagram or specimen belonging to this class. He had to obtain diagrams from all sources, and to make many of them himself, there being no great endowment for the support of the Chair. One part of his work during the eleven years had been to gather together materials for a class-museum. These he had succeeded in obtaining, partly through purchase, and partly through the kindness of friendly benefactors to the University. This collection, which would be of the greatest value in the future work of the Chair, was at present in great part stowed away in boxes, for want of space to display it. He had much satisfaction in leaving it as a legacy to his successor. Having referred to the difficulties which had attended the conducting of the class, arising from the deficiency of accommodation, two, and sometimes three professors using the same class-room, the Professor said this Chair was the first started in Scotland for the special cultivation of geology and mineralogy. He believed he was the first in Scotland, if not in Britain, to organise a practical class for the study of mineralogy and the microscopic investigation of rocks. Owing to the transference of the medical classes to the new University Buildings, his successor would have a series of class-rooms, with laboratory and museum attached, and he had no doubt a great future was in store for the prosecution of geology in the University of Edinburgh. He had tried always to make the cultivation of field-geology a prominent part of the work of the class; and some of their pleasantest associations had been among the glens of the Highlands and the hills and shores of the lowlands. In concluding, Prof. Geikie thanked the students very heartily for their kindness in the past, and for this crowning mark of their regard. Though his voice would no longer be heard within these walls, his interest in the students remained as sincere and as hearty as ever it was. They knew him well enough to be assured that his students had been, and always would be, to him personal friends. "And now, gentlemen," he concluded, "long live our dear old *Alma Mater*, and God bless you all."

THE following is the award of the Public Schools' Prize Medals of the Geographical Society for 1882:—Physical Geography (Examiner Prof. H. N. Moseley, M.A., F.R.S.): Gold Medal, Hubert Llewellyn Smith, Bristol Grammar School; Silver Medal, Albert Richard Sharp, Dulwich College. Honourably mentioned: Andrew Claude Crommelin, Marlborough College; Montague Edward Fordham, London International College; Samuel William Carruthers, Dulwich College; Albert Lewis Humphries, Liverpool College. Political Geography (Examiner, Sir Arthur Blyth, K.C.M.G., Agent-General for

South Australia): Gold Medal, Frank Herman Becker, Dulwich College; Silver Medal, Sydney Charles Farlow, Harrow School. Honourably mentioned: Robert Galbraith Reid, Dulwich College.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, February.—On the behaviour of steam in the steam-engine cylinders, and on causes of efficiency, by R. H. Thurston.—What is the most economical point of cut-off for steam-engines, considered as a question of finance? by W. D. Marks.—Contribution to the history of the link motion, by J. L. Whetstone.—A new theory of the suspension system with stiffening truss, by A. J. Dubois.—Steamship performance, by J. W. Nystrom.—Radio-dynamics; atomic phyllotaxy and kindred harmonies, by P. E. Chase.

Bulletin de l'Académie Royale des Sciences de Belgique, No. 12, 1881.—On the probable cause of variations of latitude and terrestrial magnetism, by F. Folie.—Remarks on the electric phenomena which accompany variations of the potential energy of mercury, by G. Van der Mensbrugghe.—On compound ethers of hyposulphurous acid, by W. Spring and E. Legros.—On the action of chlorine in sulphonic combinations, and on organic oxysulphides, by W. Spring and C. Winssinger.—On the action of chlorine on tertiary butylic alcohol, by Baron d'Otreppe de Bouvette.—On the structure of gemmiform pedicellaria of *Sphærechinus granularis* and other Echinida, by A. Fœttinger.—Researches on the organisation and development of Orthonectides, by C. Julin.—On the respiratory oscillations of the arterial pressure in the dog, by L. Fredericq.—On the delimitation and constitution of the lower coal-formation of Belgium, by J. C. Purves.—On the oscillations of blood-pressure called Periods, of Traube-Hering, by L. Fredericq.—A page of the history of a whale, or cetology fifty years ago: lecture by P. J. Van Beneden.—History of astronomy in Belgium: lecture by F. Folie.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti, vol. xv. fasc. iii.—Meteorological *résumé* of the year 1881, calculated from observations made in the Royal Observatory of Boera, by E. Pini.—On the achromasia of aphaneri (*i.e.* colourlessness of certain minute organisms), by L. Maggi.—On the toxical action of hydroxylamine, by C. Raimondi and G. Bertoni.

Atti della R. Accademia dei Lincei, vol. vi. fasc. 6.—On Hieratite, a new mineralogical species, by A. Cossa.—On monobromopyridine, by L. Danesi.—Observations in addition to the memoir entitled "On an Organ of some Vegetable Embryos," by G. Briosi.—On the extraordinary atmospheric pressure of January, 1882, by L. Respighi.

Bulletins de la Société d'Anthropologie de Paris, tom. iv. fasc. iii., 1881.—M. Thulié concludes his paper on the differences between the true Bosjesmans and Hottentots, the former of whom he regards as survivors of an aboriginal, and once predominant race.—M. Topinard's report of his observations on the indigenous races of Algeria during a brief sojourn in that province, has given occasion—through his disregard of his own rules of ethnological inquiry, and his hastily formed views based on mere appearance—to the most interesting of the papers and discussions reported in these *Bulletins*. Among these are the comprehensive expositions which M. Topinard gave at a subsequent meeting of his "Méthode d'observation sur le vivant à propos de la discussion sur l'Algerie," and the description of his own modification of "Broca's Goniometer for measuring Cuvier's facial angle on the living subject."—M. Sabatier, in a paper on the different appellations used by the ancients to designate the peoples of Africa, endeavours to prove the existence of close analogies between Sanskrit, Greek, and the Berber dialect, as shown in the names of leading African peoples, which he derives either from their predominant occupations, or the nature of the region in which they dwelt.—M. Ameghino describes the result of his recent explorations of the Chelles beds, in which no human remains have been found, while those of the elephant, rhinoceros, and cave-bear are numerous, together with an abundance of aqueous, but no terrestrial shells.—M. Cavaroz reports his discovery of an atelier of flint implements in the Jura, near Salines, which appears to belong to the Neolithic age.—M. le Baron pre-ented his report on prehistoric osseous lesions, which forms the subject of his inaugural thesis, and is based on a study of the specimens contained in the Broca, and the Society's, Museum. The list of diseases includes most of the modern forms, common in infancy and advanced age, while the numerous instances of trepanning, and the not infrequent cases of well consolidated fractures show that primæval man was not wholly negligent, or unskilled in regard to surgical methods.—A new case of so-called hermaphrodism reported by M. Magitot, gave rise to considerable discussion, in the course of which it was agreed that the use of the term was not in harmony with the present state of physiological inquiry, and that the abnormalities in question ought to be included under the general head of malformations, or embryonic arrest of development.—We have further to notice papers by Madame Clemence Royer, on "Le Bien et la loi Morale"; by M. Zaborowski on the memory and its disturbances; by Mr. Foley, on the relations between the mode of life and character of tropical peoples, and the humid climate in which they live; and finally, two highly important communications, received from M. de Ujfalvy, on the craniometric and other measurements made by him while travelling in the Thibetian, Kashmir, and other Indian territories. His observations on the Baltis, Lhassas, Ladakis, Koulous, and Laboulis—the two last-named of which practise polyandry, and follow a degraded form of Bouddhism—supply highly interesting, and hitherto unknown materials towards our better acquaintance with the ethnological and sociological history of these tribes.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 9, 1882.—"On the Spectrum of Carbon," by G. D. Liveing, M.A., F.R.S., Professor of Chemistry, and J. Dewar, M.A., F.R.S., Jacksonian Professor, University of Cambridge.

Angström and Thalén, in their memoir "On the Spectra of the Metalloids" (Nova Acta Reg. Soc. Upsal., Ser. iii. vol. ix.), give a map and table of wave-lengths of the lines due to carbon in the visible part of the spectrum, as distinguished from the fluted spectra given by compounds of carbon, namely, carbonic oxide, cyanogen, and acetylene. These lines, they state, always appeared when very powerful induction sparks were passed through the vapour of any compound of carbon, or between carbon electrodes. This line-spectrum is remarkable for simplicity, consisting of eleven lines, of which the single line in the yellow, followed by a triple group in the green, and a very strong line in the blue, recall vividly the spectrum of magnesium; and as we know two modifications of the spectrum of magnesium which seem to be due respectively to the oxide and a hydride, the parallel between the behaviour of the two elements is the more striking.

The authors figure the ultra-violet spectrum of carbon to a scale of wave-lengths within the range of the rays transmitted through calcite. The lines figured have been observed in photographs of the spark of a large induction coil, having a large Leyden jar in connection with the secondary coil, between poles of purified graphite in air, carbonic acid gas, hydrogen, and coal-gas. The same lines have been observed in photographs of the spark between iron, and between aluminium poles in carbonic acid gas. By comparing the photographs taken under these different circumstances, they have, they believe, eliminated the air-lines, which are numerous and strong in the region between H and T, and also the metallic lines which graphite, purified with the utmost care, still exhibited.

The graphite was purified by being stirred in fine powder into fused potash, and subsequent treatment with aqua regia, by prolonged ignition in a current of chlorine, and by treatment with hydrofluoric acid. The well-washed powder was afterwards compressed into blocks by hydraulic pressure between platinum plates, and from these blocks the electrodes employed were cut. Notwithstanding the purification, the photographs of the spark between these electrodes still showed very distinctly lines of magnesium and iron.

The wave-lengths of the strongest carbon lines were determined by means of a Rutherford diffraction grating having 17,296 lines to the inch. The measures were made in the following way:—A small photographic slide, containing the sensitive plate, fitted the telescope in place of the eye-piece, and so could easily be turned about an axis coincident,, or nearly so, with the optic axis of the telescope. In taking a measurement of the position of a line the approximate wave-length was first found by interpolating between the nearest cadmium or other lines of known wave-length in photographs taken with calcite prisms.

The telescope was then set to the angle corresponding to this approximate wave-length for the spectrum of the fourth order. The lower half of the slit was closed by a shutter, and the photographic slide having been adjusted for level, the plate was exposed to the light which came through the upper half of the slit, and gave an image of the lines in the lower half of the field. When this exposure was completed, the photographic slide was turned round through 180° about the axis of the telescope, so as to bring to the top that part of the sensitive plate which had been before lowest. It was then exposed a second time, and thus two images of the same line were impressed on the plate, which were necessarily at equal distances on either side of the point where the axis of the telescope met the plate. By a subsequent measurement with a micrometer under a microscope of the distance between the two images, and the conversion of this distance into angular measure, a correction was found, which was added to, or subtracted from, the reading of the circle to get the exact deviation of the ray producing the line under observation. Another photograph of the same line was next taken in the same way as before, except that the telescope was placed at the corresponding angle on the other side of the collimator. From the two angles thus found, the wave length of the line was calculated The process was repeated three or four times for each line, and the mean wave-lengths thus found for carbon lines were 2296·5, 2478·3, 2509·0, 2511·9, 2836·3, and 2837·2. The wave-lengths of the remaining lines were obtained by interpolation from measures of photographs on which the iron as well as the carbon lines were shown. The wave-lengths of the iron lines used in the interpolations were deduced from photographs taken with the grating in the same way as that above described for the carbon lines. The wave-lengths thus formed for the remaining carbon lines are given in the table below.

Table of Carbon Lines

Authors.	Colour.	Wave-length.	Intensity.
Ångstrom and Thalén	Red	6583·0	2
		6577·5	1
	Orange.	5694·1	4
		5660·9	4
		5646·5	3
		5638·6	5
	Yellow ...	5379·0	6
	Green	5150·5	4
		5144·2	3
		5133·0	5
	Indigo ...	4266·0	1, diffuse
Liveing and Dewar	Ultra-violet.	3919·3	2, diffuse
		3876·5	4, ,,
		2995·0	4, very diffuse
		2968·0	5, ,, ,,
		2837·3	2
		2836·3	2
		2746·5	3, very diffuse
		2733·2	6, ,, ,,
		2640·7	4, ,, ,,
		2541·5	6
		2528·2	5
		2523·6	5
		2518·7	5
		2515·8	4
		2514·0	5
		2511·9	2
		2509·0	3
		2506·6	5
		2478·3	1
		2296·5	3

They have also examined the spectrum of Swan's incandescent lamps. So long as the carbon thread is unbroken, it emits a continuous spectrum, on which neither bright nor dark lines are visible. By gradually increasing the number of cells in the battery, until the thread gave way, they found at the instant of fracture, for a small fraction of a second only, that a set of flutings in the green appeared. In some of those lamps, when the current was nearly as much as the carbon thread would bear without rupture, a sort of flame appeared in the lamp. On examining the spectrum of this flame, it gave the flutings of carbonic oxide very distinctly. Closer examination showed that this flame was strongest about the junction of the carbon thread with one of the conducting wires, and that, on reversing the current, it shifted from one wire to the other, and the wire about which it appeared was always the positive electrode. In fact, the flame was the glow of the positive pole attending a discharge in rarefied gas; when the resistance of the carbon thread became too great in proportion to the intensity of the current, the discharge began to occur through the rarefied atmosphere within the envelope of the lamp. The spectrum showed that this atmosphere contained carbonic oxide.

By interposing different flames between the incandescent lamp and the slit of the spectroscope, they have made some comparisons of the probable temperatures of the flames and filament. When the flame was that of a Bunsen burner, in which was a platinum wire with sodium carbonate, the yellow sodium lines were seen bright above and below the continuous spectrum of the carbon thread, but reversed where they crossed it. When lithium was substituted for sodium in the flame, the red lithium line was also seen bright above and below the continuous spectrum, but reversed where they crossed it. When an oxyhydrogen jet was substituted for the Bunsen burner, and sodium carbonate held in it, the yellow sodium lines were not only bright above and below the continuous spectrum of the carbon, but showed as bright lines where they crossed it; in fact, they were conspicuously brighter than the carbon. When coal-gas was substituted for hydrogen in the jet, the same appearance presented itself, only the sodium lines were not so much brighter than the carbon as they were before. Fifty Grove's cells were used with the incandescent lamp, which were as many as could be used without danger of rupturing the threads. When barium chloride was held in the hydrogen flame fed with only a little oxygen, the bright green line of barium (wave-length 5534) was well seen above and below the continuous spectrum, but could not be traced either bright or dark across it. When a flame of cyanogen burning in air was interposed, the bright bands of that flame could be seen above and below the continuous spectrum, but could not be traced either bright or dark across it. When sodium carbonate was held in this flame, the yellow sodium lines were seen feebly reversed where they crossed the spectrum of the incandescent lamp. They infer from these experiments, that the emissive power of the carbon thread for light of the refrangibility of the D lines is nearly balanced by that of sodium in the flame of cyanogen burning in air, but is sensibly less than that of sodium, at the temperature of a jet of coal-gas and oxygen, much less than that of sodium in the oxyhydrogen jet. This seems to render it probable that the temperature of the incandescent thread is not far different from that given to sodium by a cyanogen flame burning in air, but is less than that of an oxyhydrogen flame, though this does not necessarily follow from the experiments, inasmuch as the radiation of the sodium is so much more limited as to range than that of the carbon. When a Bunsen burner or a gas blowpipe flame was interposed between the lens and slit, no reversal of the hydrocarbon bands could be seen. When magnesium was burnt between the lens and slit, the magnesium lines (*b*) were seen bright, eclipsing the carbon. Possibly the smoke of magnesia may have considerably helped to eclipse the light of the carbon.

Chemical Society, March 16.—Prof. Roscoe, president, in the chair.—The following papers were read:—On valency, by Dr. Armstrong. The bulk of this paper is taken up with a consideration of the valency of carbon in the hydrocarbons, and especially with the formulæ proposed by Kekule and others for benzene. The author concludes that a simple hexagon in which carbon acts practically as a triad, agrees best with the various reactions of benzene.—Contributions to the chemical history of the aromatic derivatives of methane, by R. Meldola. The author investigates the action of benzyl chloride upon diphenylamine, and the action of oxidising agents upon the product. The substance thus produced is a green dye, "viridin," which by the action of strong sulphuric acid forms sulphonic acids, the alkaline salts of one of these acids dyes woollen fabrics from an alkaline bath. This colour is the chloride of a base which the author has proved to be diphenyl diamidotriphenyl carbinol.—On some constituents of resin spirits, by G. H. Morris.—The lower fractions of resin spirit yield on standing a crystalline substance. This body has been examined by the author. It has the formula

$C_7H_{14}O_2H_2O$; it is formed from a hydrocarbon heptin C_7H_{12}, boiling at 103° – 104°, contained in resin spirit. The author has also studied the action of nitric acid, permanganate, &c., on heptin.—On pentathionic acid, by Watson Smith and T. Takamatsu. The authors reply to criticisms advanced by Lewes, Spring, Curtius, &c., on their previous work, and give further experiments on the subject.—On the preparation of diethyl naphthylamine, and the action thereon of sulphuric acid at high temperatures, and of phosgene gas, by B. E. Smith.

Chemical Society, March 30.—Anniversary Meeting.—The president, Prof. Roscoe, F.R.S., gave his annual address, and congratulated the Fellows on the satisfactory condition of the Society, both numerically and financially: 1175 Fellows are now enrolled on the register.—A ballot was then held for the election of Officers and Council, and the following were duly elected:—President, Dr. J. H. Gilbert. Vice-presidents: F. A. Abel, Warren De La Rue, E. Frankland, J. H. Gladstone, A. W. Hofmann, W. Odling, Lyon Playfair, H. E. Roscoe, A. W. Williamson, A. Crum Brown, J. Dewar, P. Griess, A. V. Harcourt, J. E. Reynolds, E. Schunck. Secretaries: W. H. Perkin, H. E. Armstrong. Foreign Secretary, Hugo Müller. Treasurer, W. J. Russell. Ordinary Members of Council: E. Atkinson, W. de W. Abney, F. D. Brown, F. R. Japp, H. McLeod, G. H. Makins, E. J. Mills, L. O. Sullivan, C. Schorlemmer, J. M. Thomson, W. Thorp, T. E. Thorpe.

Meteorological Society, March 15.—Mr. J. K. Laughton, F.R.A.S., president, in the chair.—The following gentlemen were elected Fellows of the Society:—T. H. Baker, J. T. Barber, W. H. Jackson, Capt. J. Simpson, R. F. Sturge, and Sir B. J. Sulivan, K.C.B.—The president (Mr. J. K. Laughton) gave a historical sketch of the different classes of anenometers. He remarked that anemometers are instruments for measuring the strength of the wind; they are of different classes, according as the strength is estimated by the pressure on a surface, or by the velocity, by its power of suction, or by its cooling effects. Those that measure pressure may do so either by causing the plate which receives the wind to swing backwards along a graduaed quadrant, or by bridling, that is, restraining that motion, and observing the resistance called into play; or by receiving the wind on a plate which can only move backwards, against either a spring, a lever attached to a weight, or a column of liquid. Others, again, receive the wind on the surface of the liquid, and show the pressure by the disturbance of the equilibrium in a siphon tube. At the present time, and in this country, instruments that measure velocity are more generally preferred, the type now commonly adopted being that known as Robinson's cups, in which four hemispherical bowls placed at the arms of a horizontal cross cause it to rotate freely as the wind blows against them. But many very different instruments have been used for measuring velocity, the most primitive of which was a disc of cork, fringed with light feathers—a species of shuttlecock—travelling freely along a considerable length of fine wire stretched in the direction of the wind. Rotation has, however, been the favourite way of bringing the motion of the wind within reach of the observer, and to get that rotation almost every conceivable form of wheel or fan would seem to have been tried. What are known as suction anemometers depend on the hydraulic principle of the lateral communication of motion by a stream. A current of air blowing across the open end of a pipe draws the air out of that pipe, causing within it a partial vacuum, which, by various arrangements, can be measured, the relative vacuum depending on the strength or velocity of the wind which gives rise to it. Several different methods have been adopted for measuring this vacuum; but, though anemometers constructed on this principle take hold of the imagination by their neatness and simplicity, the unknown amount of disturbance due to friction, or—when long pipes are used—to vibration, prevent their being received at present as satisfactory gauges of the wind's velocity. Other anemometers have been made on the principle that the evaporation of water, or the cooling of a heated surface—other things being equal—goes on at a rate proportional to the velocity of the wind; but, in practice, it has been found difficult to insure the equality or uniformity of conditions, or to make correct allowance for their difference, and at least one very ingenious instrument, by receiving the air into different pipes, opening different valves according to its varying strength, causes them to give out two simultaneous but distinct musical notes, the one of which answers to a definite direction, the other to a definite velocity. Such things can, at present, only be considered as pretty and ingenious toys: they can, undoubtedly, mark a difference between one wind and another, but are quite unequal to giving any exact measure of relative and still more absolute force. Even the more generally recognised types of anemometer, the very commonly used pressure plates of Mr. Osler, or the revolving cups of the late Dr. Robinson, are by no means entirely satisfactory. The action of stream lines in front, or of the partial vacuum behind the exposed surface, leads to curious vagaries, difficult to understand, and as yet impossible to correct. But till they are understood and corrected, anemometry, as a science, stands on a very uncertain basis. The President, in conclusion, said that what we want is not so much new and improved apparatus for registering or recording; for though those we have are not perfect, they are far superior to the anemometers they are applied to. What we want is rather some radical improvement in the instrument itself or in the theory which translates its action. It is to this that we would wish more especially to call the attention of all meteorologists.—In connection with this meeting there was an exhibition of instruments, consisting of anemometers and new meteorological apparatus, &c. The anemometers exhibited were forty-five in number, and included, among others, those of Beckley, Biram, Cator, Hagemann, Howlett, Lind, Lowne, Osler, Oxley, Robinson, Ronalds, Somerville, Whewell, and Wild. There were also photographs and drawings of old forms of anemometers, damage caused by whirlwinds, &c.

Zoological Society, March 21.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. J. E. Harting, F.Z.S., exhibited and made remarks on a mummified bird of the genus *Sala*, and some eggs from the guano-deposit of an island off the Pacific coast of South America.—Mr. Sclater made some remarks on "lipotypes"—a new term which he considered convenient, in order to designate types of life, the absence of which are characteristic of a particular district or region. Thus, *Cervus* and *Ursus* were "lipotypes" of the Æthiopian region.—Dr. A. Günther exhibited and made remarks on the skin of a pale variety of the Leopard from the Transvaal. Dr. Günther also exhibited and remarked upon a specimen of a new Turtle (*Geoemyda*) from Siam.—Mr. R. Bowdler Sharpe exhibited a specimen of a Goldfinch from Hungary, sent to him by Dr. J. von Madarasz, of the Museum of Buda-Pest, which that gentleman had described as *Carduelis elegans albigularis*. Mr. Sharpe observed that a white-throated variety of the Goldfinch was by no means unknown in England.—Dr. Hans Gadow, C.M.S., read a paper on some points in the anatomy of *Pterocles*, with remarks on its systematic position. Detailed descriptions of the alimentary organs and of the muscles were given. The author took the opportunity of discussing the classificatory or systematic value of the cæca in birds. Then, after pointing out the difficulties of placing the Sand-Grouse in the Avian system, he came to the conclusion that the *Pterocletes* (Sclater) should be considered as a group co-ordinate to the Rasores, Columbæ, and Limicolæ, between which they formed a connecting link.—Mr. W. A. Forbes read a note on a peculiarity of the trachea in the Twelve-wired Bird of Paradise (*Seleucides nigra*) as observed in a male specimen that had recently died in the Society's Gardens.—Mr. Bowdler Sharpe read a note on the *Strix oustaleti* of Hartlaub, and pointed out that this bird was none other than the Grass-Owl (*Strix candida*).—Capt. G. E. Shelley gave the descriptions of some new species of birds which had been obtained in the neighbourhood of Newcastle, Natal. These the author proposed to name *Anthus butleri* (a very interesting Yellow-breasted Pipit), *Sphenœacus natalensis* (the Natal representative of *S. africanus*), and *S. intermedius* (an intermediate form from Kaffraria).—Messrs. Godmin and Salvin read a paper, in which was given the descriptions of some new species of Butterflies of the genus *Agrias*, from the valley of the Amazons.—Mr. E. J. Miers read an account of a collection of Crustaceans which had been made by M. V. de Robillard, at the Mauritius. The author called special attention to a fine Spider-crab dredged up from a depth of eighty fathoms, which he proposed to name *Naia robillardi*.

Geological Society, March 22.—J. W. Hulke, F.R.S., president, in the chair.—William Brown, George Thomas Parnell, and Edwin Alfred Walford, were elected Fellows of the Society.—The following communications were read:—On a fossil species of *Camptoceras*, a freshwater mollusc, from the Eocene of Sheerness, by Lieut.-Col. H. H. Godwin-Austen, F.R.S.—Note on the os pubis and ischium of *Ornithopsis eucamerotus* (synonyms—*Eucamerotus*, Hulke; *Bothriospondylus* (in part), R. Owen; *Chondrosteatosaurus*, R. Owen)," by

J. W. Hulke, F.R.S., Pres.G.S In this paper the author reviewed the various contributions to the knowledge of this Dinosaur, for which he adopted Prof. Seeley's generic name *Ornithopsis*, and employed the name *eucamerotus*, originally applied by him to the genus, as the specific name. He also discussed the affinities existing between *Ornithopsis* and certain other Dinosaurs, such as *Cetiosaurus* and the American genera *Camarosaurus*, *Atlantosaurus*, and *Brontosaurus*. He then described the pubis and ischium which have recently been acquired by the British Museum from the collection of the late Rev. W. Fox, by whom they were purchased, together with the finest typical thoracic vertebræ of *Ornithopsis*.—On *Neusticosaurus pusillus* (Fraas), an amphibious reptile having affinities with the terrestrial Nothosauria and with the mari e Plesiosauria, by Prof. H. G. Seeley, F.R.S. These remains come from the Lettenkohle, a stratum between the Upper Muschelkalk and Keuper, and were obtained at Hoheneck, about 9 miles north of Stuttgart. They have been already noticed by Dr. Fraas under the name of *Simosaurus pusillus*; but the palate differs much from that of this genus, and from all others that are known. *Neusticosaurus* is the smallest representative of the Plesiosauria yet known, and has a special interest as exhibiting hind limbs with the characteristics of a terrestrial animal, while the fore-limbs are modified into paddles.

Victoria (Philosophical) Institute, April 3.—A paper on materialism was read.

Paris

Academy of Sciences, March 27.—M. Jamin in the chair.—The following papers were read:—Double decompositions of haloid salts of silver, by M. Berthelot.—On the velocity of propagation of explosive phenomena in gases, by MM. Berthelot and Vieille. Small detonators (of fulminate) had been used, breaking circuits as the waves passed; and the velocity observed is now shown to be independent of these. It is also found independent of the diameter of the tubes beyond 5 mm.—Instantaneous photographs of birds in flight, by M. Marey.—On the variations observed in the herring fishery on the Norwegian coasts, by M. Broch. These variations, long recorded at Bergen, seem to depend on the movements of large banks of animalculæ, which are the herring's food, towards or away from the coast; and these displacements are probably due to variations in marine currents and dominant winds, which require investigation.—First succour to the wounded on the battlefield, by M. Fournier. He indicates, in photographs, means that may be used, where ambulance-aid cannot be had.—Comet discovered in America, on March 19, 1882; observations at Marseilles Observatory, by M. Coggia.—Observations of the comet at Paris Observatory, by M. Bigourdan.—Observations of solar protuberances, faculæ, and spots at the Observatory of the Roman College during the fourth quarter of 1881, by M. Tacchini. *Inter alia*, the protuberances diminished in number, from a maximum in September; but they were nearly twice as numerous as in the same quarter of 1880. Their height and extent had increased very little. Spots and faculæ showed, as before, two maxima between $\pm 10°$ and $\pm 30°$.—On hypercycles, by M. Laguerre.—On Pfaff's problem, by M. Darboux.—On a group of linear substitutions, by M. Picard.—On discontinuous groups, by M. Poincaré.—On the application of the resistance of materials to the pieces of machines, by M. Léauté.—On the compressibility of gases, by M. Sarran. Clausius' formula represents, with much exactness, the compressibility of six gases studied.—On the relation $\phi(v, p, t) = 0$ relative to gases, and on the law of dilatation of these substances at constant volume, by M. Amagat.—On a certain class of equipotential figures, and on M. Decharme's hydraulic imitations, by M. Guébhard.—Telephonic indicator of the torsion and velocity of rotation of the motor-axis of machines, and consequently of the work, by M. Resio. This enables a single observer to make the measurements at a distance. The principle is that of the induction balance.—Action of telephonic currents on the galvanometer, by M. de Chardonnet. Sounds of uniform intensity do not affect a sensitive galvanometer, but the needle is deflected when the intensity varies, the direction being opposite in increase and decrease. This is easily explained.—On the absorption-spectrum of ozone, by M. Chappuis. The spectrum is more characteristic than any other properties; the author specifies the wave-lengths of the bands, and describes their appearance and order of occurrence under varying conditions.—Researches on ozone, by Abbé Maillfert. This relates to action of ozone on organic matters, on several metallic oxides and sulphides, and on salts whose bases are susceptible of suroxidation.—Action of alkaline solutions on protoxide of tin, by M. Ditte.—Experimental researches on the constitution of cements and the theory of their hardening, by M. de Chatelier. He examined thin plates of Portland cement with the polarising microscope, and indicates the substances present and those produced in hardening.—On campholurethane, by M. Halles.—Action of cyanogen on sodised menthol, by M. Arth.—Preparation of pure carbon for electric lighting, by M. Jacquelain. The method is, directing a current of dry chlorine for thirty hours on several kilogrammes of crayons of retort-carbon heated to a bright red, and afterwards letting carburet of hydrogen vapour circulate slowly among them for five or six hours; another method, action of fused caustic potash or soda; a third, action of hydrofluoric acid. The author also prepares directly pure graphitoid carbon by decomposition of organic substances through heat. A photometric table of different carbons is given.—Intestinal digestion, by M. Duclaux.—The microzymas of the stomachal glands and their digestive power; reply to the question, Does the stomach digest itself? by M. Béchamp. The stomachal mucous membrane is digested by the microzymas, but the production of new cells is superior to the consumption.—Researches on pancreatic albuminoses, by M. Béchamp.—On trichinæ in salt meat, by M. Colin. American salt meat, as now imported, may, only in rare cases, transmit trichinosis where the pieces are recent, or large and badly-impregnated.—Similarity of effects of central and cortical lesions of the brain, by M. Couty.—On the reproductive apparatus of star-fishes, by MM. Perrier and Poirier.—Development of the ovum of *Podocoryne carnea*, by M. de Varenne.—On the present state of monetary and note circulation, with some indications as to modifications following on extension of the metric system, by M. de Malarce. England uses relatively the fewest monetary instruments (metallic or note money); France much more. The total for the former is 4,800 million francs, for the latter 8,600 million.

Vienna

Imperial Academy of Sciences, March 30.—L. I. Fitzinger in the chair.—J. Barrand, "Système silurien du centre de Bohême" (vol. vi., containing the Acephala, with 361 tables).—M. Kovatsch, on the sand covering of Venice and its causes.—H. John, on the vapour density of bromine.—On the knowledge of amine bases of secondary alcohols, by the same.—F. Reinitzer, studies on the reaction of acetates of chromium, iron, and aluminium.—An analysis of a vegetable fat, by the same.—T. Puluj, on radiant electrode-matter (ii.).—E. Tangl, on the division of nuclei of Spirogyra cells.—F. Berwerth, on the chemical composition of amphiboles.—Dir. Steindachner, batrachological contributions.—G. Tschermak, on the meteorites that fell near Mocs (Transylvania).—E. Weiss reported on the elements and ephemeris of the comet discovered by Mr. Wells at Boston (U.S.A.) on March 18, computed at the Vienna Observatory by E. Holetschek.

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THURSDAY, APRIL 13, 1882

THE COINS OF THE JEWS

The International Numismata Orientalia. Vol. ii. *Coins of the Jews.* By Frederic W. Madden, M.R.A.S. (London : Trübner and Co., 1881.)

THIS goodly quarto of nearly 350 pages, illustrated by 279 woodcuts, forms the second volume of the International Numismata Orientalia, which has been for some time in course of publication under, we believe, the chief editorship of Mr. Edward Thomas. The work now before us may be regarded as being virtually a second edition of Mr. Madden's "History of Jewish Coinage and of Money in the Old and New Testaments," which was published in 1864; but in many respects the book has been so much enlarged, and we venture to think improved, that it may almost take rank as a new work. Any summary of the strictly numismatic details of such a publication would be out of place in the pages of NATURE, but the public interest in all modern researches in the Holy Land, such as those carried on under the Palestine Exploration Fund, and the success that has attended the foundation of the Society of Biblical Archæology, prove the strong hold which, in this, and indeed in all Christian countries, the cradle of our religion retains.

Of contemporary witnesses of history, coins are among the best, but since the days of Bayer, the Archdeacon of Valentia, who wrote "De Nummis Hebræo-Samaritanis" just a century ago, there was a lull in the study of this branch of numismatics until within the last thirty years, when the labours of De Sauloy, Cavedoni, Levy, Von Werlhof, Reichardt, Madden, Garrucci, Merzbacher, and others began. The results of these labours, incorporated in Mr. Madden's present work, contrast strangely with Pinkerton's estimation of the Jewish coinage, as expressed in his Essay on Medals, which for many years was almost the only work of the kind accessible in English. The first edition appeared in 1784, but even in the third edition of 1808 we read :—

"The Hebrew shekels—which are of silver—and brass coins with Samaritan characters would have been put before, were not, most of them, later than the Christian æra, and generally the fabrication of modern Jews. At any rate the same impression of a sprig on one side and a vase on the other runs through all the coins of that barbarous nation ; and the admission of but one of them is rightly esteemed to be almost a disgrace to a cabinet."

Certainly so far as art is concerned, the best and earliest of the Jewish coins compare unfavourably with those of the contemporary Seleucid rulers in Syria. For it must not be imagined that the Jewish shekel, notwithstanding its frequent mention in Scripture, was at any time an actual piece of coined money before the days of the Maccabees—or at the earliest, the time of Alexander the Great and the high priest Jaddua. If we accept the views of Dr. Merzbacher, who is probably the most competent judge in this matter, the earliest of the Jewish shekels were not struck until B.C. 141-140, when those dated ש-א, the year one, were coined. These pieces are of silver, about the size of our shillings, and fully twice as thick, and range in date from the year 1 to 5. Half shekels are known up to the year 4. The devices on the shekels are, on the one side, a cup or chalice, with the legend שקל ישראל, *Shekel Israel;* and on the other, what has been termed Aaron's rod, but what more resembles three lilies on one stem, and the legend *Jerusalem the Holy*. It is a curious circumstance, that on the coins of the first year, Jerusalem is spelt without a *yod*, and Holy is without the article and without the *vav*, ירשלם קדשה, *Jerushalem kedoshah ;* while on the later coins the legend is always ירושלים הקדושה, *Jerushalaim ha-kedoshah.*

Besides the silver coins, there is a copper coinage inscribed with "the year four," but it seems somewhat doubtful whether it belongs to the same period as the shekels bearing the same date. Possibly future finds of coins with the shekels and other pieces either Jewish or foreign intermixed may settle the question not only of contemporaneity, but of actual date. The fact of the coins of the fourth year bearing upon them the legend, "The redemption of Zion," as well as the shape of some of the letters, points to these coins belonging to a later date than the shekels. At the same time the fabric looks as if they were of earlier date than the coins of the revolts, shortly to be mentioned.

Of John Hyrcanus, Judas Aristobulus, and Alexander Jannæus there are numerous copper coins of undoubted attribution. The Herods and Agrippas are also well represented ; but among the most interesting, and at the same time perplexing coins of the series are those which were struck under the revolts against the Roman power, from A.D. 66 to 70, under Vespasian, and again under Hadrian, from A.D. 132 to 135. Without entering into any details with regard to these coins, it may be worth while to mention some of the devices upon them and to add a few words as to their palæographical bearing. Although portraits occur on coins of some of the Idumæan princes, the representation of any living creature is carefully avoided on all the more purely Jewish pieces. A favourite device is the palm tree, like which "the righteous shall flourish" ; though this was also a common device on coins of Carthage. The *lulab*, or bunch of "branches of goodly trees," and the *ethrog*, or citron, such as were carried at the Feast of Tabernacles, also make their appearance on the coins. The vine leaf and the bunch of grapes, probably typical of "the vineyard of the Lord of hosts, being the house of Israel, and the men of Judah his pleasant plant," are often represented. The flagons and cups, and the lyres or "stringed instruments" and trumpets, are probably symbolical of the Temple worship ; and on some of the shekels of the revolts we find a gateway which not improbably represents the Beautiful Gate of the Temple.

From a palæographical point of view the Jewish coinage is of great value as definitely fixing the ordinary forms of certain letters at given dates. This part of the subject is well illustrated by a folding plate comprising some thirty alphabets, from the ninth century B.C. to the tenth century after the Christian era. To these is prefixed an alphabet selected from Egyptian hieratic characters, from which M. François Lenormant and others have maintained that the early Phœnician alphabet was derived. Such a derivation appears to us at the best problematical ; but it would be too much of a digression here to enter into the question. It is more to the purpose to note that while there is in the main a close correspondence between the

letters on the early shekels and those on the Moabite stone, and on the inscription of Esmunazar, there is in the case of some letters on the copper coins of the Asmonæan family, which are regarded as being but a few years later in date, a marked divergence. This is notably the case with the letters ה, ו, and ש; and singularly enough these three letters revert to the forms employed on the silver shekels on some of the coins struck during the revolts, though the position of the letters is in some cases changed. Possibly the modification in the characters is due to their being so much smaller on the copper coins than on the silver. The persistence of the Phœnician or, as it may here be called, the Jewish or Samaritan character, is well exemplified by the legend on the shekel. It is of course retrograde, or to be read from right to left. The legend stands LF9WN LPW, but when reversed, and the position of some of the characters slightly altered, it comes out as ΣPL ᒣLΣPΛL, in which SQL ISRAL can at once be seen, especially by eyes to which the Greek Σ and P are familiar.

Any notice of Mr. Madden's book would be incomplete without some reference to the Roman coins struck in commemoration of the Conquest of Judæa, of which excellent woodcuts are given. "Beneath her palm here sad Judæa weeps," while the captive warrior with his hands bound behind him, and his armour strewn upon the ground admirably typifies "How are the mighty fallen, and the weapons of war perished!" The sections devoted to money in the New Testament and to counterfeit Jewish coins will be read by many with interest, while the opening chapters on the early use of silver and gold, and on the invention of coined money, contain an excellent summary of our present knowledge. To the numismatist a work like the present is of special value, but we think that the ordinary student who neither knows nor cares in the smallest degree for coins as tangible objects for study or collection, will find much to reward him for a perusal of the non-numismatic parts of the volume, while to the theologian, and especially to the student of Jewish history, much of the information here contained is almost indispensable.

JOHN EVANS

THOMPSON'S LESSONS IN ELECTRICITY

Elementary Lessons in Electricity and Magnetism. By Silvanus P. Thompson, B.A., D.Sc., F.R.A.S., Professor of Experimental Physics in University College, Bristol. (London: Macmillan and Co., 1881.)

WE are glad to welcome a really admirable attempt to place before students the modern doctrines concerning electricity and magnetism in a popular but reasonably accurate form. The book begins with a rapid historical sketch of the long known facts on which it is the custom to dilate in every elementary text-book on electricity; but the historical statements indicate by little additional details that they have not been simply copied from the joint-stock property of text-book writers, but that some original authorities have been referred to. This portion of the book occupies the first 190 pages, and it does not call for special remark; the illustrations are, as a rule, familiar ones, but there is a very convenient magnetic map of England for 1888 as a frontispiece; and everything relating to the use of iron filings is well and clearly put, as would naturally be expected. The author's statements of the well-worn facts are moreover interspersed with notes and characteristic touches which redeem them from dulness.

The second half of the book commences in Chap. IV. with the principle of electrostatic measurement and the definition of potential, which the author proceeds to apply to various cases; and he succeeds in giving the theory of attracted disk electrometers and of the capacity of condensers in a way which it is very satisfactory to find in so small a book. It is in the possession of this more strictly scientific information that the book differs from its predecessors in the same line, and we think the author has shown much ingenuity in contriving to pack into so small a compass not only all the ordinary popularly known facts, but also a considerable amount of more advanced science, which will be most acceptable to teachers and to students, who have long been accustomed to a great gap between mere experimental treatises on the one hand, and advanced mathematics on the other.

After the chapter on Electrostatics comes one on Electrodynamics and Magnetic Measurements, which is very well done, though necessarily too concise to be in all parts readily intelligible to a beginner. It contains a reference to Rowland's convection experiment and to Hall's effect. The chapter which follows, on Ohm's law, is perhaps the least satisfactory in the book. We are not satisfied with the statement of Ohm's law, nor with what is said concerning the meaning and measurement of resistance. Towards the end of the book comes a brief account of the Siemens' and Gramme machines, of Planté cells, of telegraphs, telephones, and the electric light. There is also a chapter on "Electro-Optics," which refers to Dr. Kerr's discoveries and to Maxwell's theory of light.

If it is necessary to say anything by way of general criticism, it is that the author sometimes shows a disposition to theorise a little too baldly, and to state without qualification, and with an air of certainty and completeness, views concerning the nature of electricity, which, though undoubtedly they have some truth in them, *i.e.* which certainly are steps towards the truth, yet have no finality about them, and which require to be cautiously worded and expressed lest they should mislead. For instance, his statements in the preface that "electricity is not *two* but *one*"; that, "whatever it is, it is not *matter* and not *energy*"; that "it may be heaped up in some places and will do work in returning to its former level distribution," are all, considered strictly, unjustifiable dogmas of the kind we have mentioned. A student ought to be puzzled by the unqualified statement "that more electricity can be made to appear at one place and less at another" when he has learnt from Maxwell that it always behaves exactly like an incompressible fluid of which all space is completely full. Neither are we altogether disposed to approve of the phrase "Conservation of Electricity," by which the author seems to set much store.

However, all these doctrines are immense improvements on the old forms of the fluid theory, and, being steps towards truth, will probably do far more good than harm. We are fully impressed with the necessity in teaching of getting *some* ideas into the heads of the students to begin with, and of polishing them up as much as possible afterwards.

On the whole, then, while we have not been able to find any statement which is certainly and distinctly wrong, we find a very great deal which is not only certainly and distinctly right but which is also exactly that concerning which a real student desires, but has hitherto been unable to obtain, information; and the whole is well and clearly written. We cannot therefore too strongly recommend teachers to adopt it at once as their text-book. O. J. L.

OUR BOOK SHELF

The Tea Industry in India; a Review of Finance and Labour, and a Guide for Capitalists and Assistants. By Samuel Baildon, author of "Tea in Assam," &c. (London: W. H. Allen and Co., 1882.)

THE history of the discovery and introduction of what is generally known as Chinese tea, though often told, has a special interest to a very large proportion of the inhabitants of the civilised world. In every country, indeed, on the face of the globe, the people use some beverage which they know as tea, and which is prepared in a similar way to that in use amongst ourselves, namely, by infusion, and often, though made from the foliage of indigenous plants, having the same chemical properties as true tea. Considering the enormous money value the cultivation of the tea plant represents not only in this country, but in China and also in India, where it is continually extending, it follows that works on this special industry would meet with a wide circulation amongst planters, and managers and directors of tea companies, notwithstanding that books and papers on the subject are by no means scarce.

The work before us is one which, though containing a a good deal of information on the practical working and financial aspects of tea planting is, moreover, written in a style that will be generally acceptable, especially among young planters, who have their way to make in the planting world, and who want the dry details or drudgery of a planter's routine of toil stated in a clear and at the same time easy manner.

We will not follow Mr. Baildon through all his chapters. A glance at the introduction will prove that his reason for writing the book has been to show that India is *the* country from whence we get the finest teas, and that it is also the country where we may look in future years for the bulk of our supply, holding out inducements, as many districts do, for the investment of capital and the application of bodily health and talent. In Chapter II., on "India the Home of the Tea Plant," quotations are largely made from the published works of well-known botanical authorities, to show that though cultivated from such a remote period in China that the plant is truly indigenous to India. The legends connected with the origin or discovery of the tea plant in China are told, one of which refers its discovery to the year of grace 510. The author points out that these legends do not prove that tea was discovered in a wild state in China. "The earliest mention," he says, "tells of people using it, and it may be inferred therefrom that they cultivated it. Precise and accurate information is obtainable as to the actual discovery of tea in Assam, *away* from habitations and in dense jungles far from 'cultivated grounds.' But similar information is not obtainable in connection with the first days of tea amongst the Chinese."

Referring to the altered character of certain districts in India now under tea cultivation, Mr. Baildon says, "Where once jungle and its deadly miasma concealed the riches and importance of the province, hundreds of thousands of acres of open land are now to be seen planted with tea. Compared with past times Assam is no longer a howling wilderness, and the change from hundreds of miles of waste into cultivated land has altered almost everything."

In proof of the superiority of Indian over China teas, the author advances many arguments and anecdotes of a powerful nature, which, however, may be summed up in the simple statement "that it is systematically used to fortify tea from China," and that there is only one case on record of anything approaching adulteration of Indian tea. It is stated that "every pound offered for sale in England can be guaranteed as absolutely pure," and this is its reputation with the trade. Mr. Baildon's statements on this head are, we believe, an honest record of facts, for it is well known that Indian teas are largely used in this country for mixing with inferior China teas. This system is well known as "blending," and is stated to be resorted to because the public taste has not yet become educated to the flavour of Indian teas alone. The English tea drinker, however, is rapidly assuming a taste for the Indian produce, and the demand for Indian tea is already very great.

On the question as to the kind of men likely to succeed as tea planters in India, Mr. Baildon has a great deal to say, and is very outspoken in what he does say. His estimate of a successful planter is evidently drawn from a thoroughly practical experience, and will no doubt serve to encourage some, as it will to discourage others.

The book has been carefully revised, and is unusually free from blunders, the author wisely omitting to go into the botanical character of the tea plants any more than a reference to the names under which the forms have been described.

A Treatise on the Theory of Determinants; with Graduated Sets of Exercises for Use in Colleges and Schools. By T. Muir, M.A., F.R.S.E. (London: Macmillan, 1882.)

THERE has been a tendency of late among some of our mathematical writers to specialise their labours; thus, Dr. C. Taylor has confined his work chiefly, if not mainly, to the geometry of conics; and our present author, to the subject of determinants. This is, we think, a good practice. Mr. Muir is no novice, and has done good work in this field, much of which is original. We have long desiderated some such work as this. Mr. Scott's is very able, but we cannot but think it is hard for junior students. Mr. Muir, we are disposed to believe, has made the introduction to the subject easier for this class, at the same time that he brings before the reader all that could be expected in a text-book. The work before us consists of three chapters, the two first of which do not err on the side of brevity; but this fulness serves a purpose, viz. "that the reader may become thoroughly familiarised with the definition," which, by the way, is too long for us to reproduce here. Though the enunciation is long, the idea is easily grasped, and when taken in connection with the illustrations, is not likely to give much trouble to the student to master it. These chapters, as indeed the remaining one also, are copiously illustrated by graduated exercises. The third chapter is much more condensed in style, and treats of determinants of special form, viz. continuants, alternants, symmetric determinants, Skew determinants, and Pfaffians, compound determinants, and determinants whose elements are differential coefficients of a set of functions, to wit Jacobians, Hessians, and Wronskians.

In a final chapter is given an interesting historical and Bibliographical Survey, from which the reader learns that contributions have been made to the subject from the publication of the germinal idea (long unfruitful) by Leibnitz in 1693, down to this present work. We may refer for further information to the chronological "List of Writings on Determinants" (1693-1880), published by Mr. Muir in the *Quarterly Journal of Mathematics* for October, 1881. This, the completest list we have seen, was to have formed part of the present work. Though we have carefully read the book through, with the exception of the exercises, we have detected but three or four

typographical errors. There are appended "Results of the Exercises." We take leave of Mr. Muir with the hope that he may be soon called upon to revise his book, with a view to the issue of a second and succeeding editions.

Experimental Chemistry for Junior Students W. Emerson Reynolds. Part II. *Non-Metals.* (London: Longmans, Green and Co., 1882.)

THIS is a most excellent little book on experimental chemistry, and should be especially useful to medical students, for whom it is chiefly designed.

There is a very large amount of useful information and descriptions of experiments in clear, but not too commonplace language, to make a beginner using the book feel at any loss when he shall come to use a larger work. The experiments are numbered for reference, and are also in most cases explained by an equation in symbols.

The student who works through this book will certainly know something practical of chemistry, as it can scarcely be used as a cram book.

We notice that in some of the formulæ and equations the symbols are adorned with dashes, which it is to be hoped have been explained in the first part, otherwise they would be somewhat misleading, or at least confusing to students at the stage at which they commence to use the book.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Vivisection

IN NATURE (vol. xxv. p. 482) there is a letter signed "Anna Kingsford," to which I feel compelled to reply. Not that I contemplate convincing your correspondent of her error, for I have only *facts* to offer; I write only for the unprejudiced portion of the English public, to protest with indignation against the calumnies regarding physiology and so-called vivisection, especially as practised here by Prof. Schiff.

The theoretical arguments for and against vivisection have been discussed to satiety; I wish to keep strictly to a question of facts, and the only passages in Mrs. Kingsford's letter against which I protest, are the words, "the *horrible tortures* perpetrated by Professors Schiff, Mantegazza, and Paul Bert"; "the atrocities of vivisection"; "the prolonged and exquisite torments to which domestic animals are subjected"; and other similar passages. In the first place, Mrs. Kingsford shows how ignorant she is of the subject she undertakes to enlighten the public upon, by mentioning Mantegazza as "a fair type" of a Continental vivisector, when the truth is that Mantegazza did long ago make some experiments on living animals, but has not done so for very many years, is, in fact, not a vivisector.

As I have not been in Prof. Paul Bert's laboratory, and have therefore not been an eye-witness of his methods, I will say nothing of the attack against him.

I now come to Prof. Schiff, who, of all living physiologists, is the one who carries out the most numerous experiments, and who may therefore fairly be taken as a typical representative of physiological research on the Continent. Having been for the last two years constantly in the learned professor's laboratory (and, I may add, in a perfectly independent position), I am able to give authoritative testimony as to his methods of study, and this testimony is, that *never* during this time was vivisection practised on a *feeling* animal; and I have repeatedly heard Prof. Schiff (whose word no one will dare to doubt) declare that he never in his life had operated on an animal that could feel pain—a fact which any one who knows this pre-eminently humane and kind man, will readily understand. I do not say that no vivisections are carried out; on the contrary, often several operations included under this comprehensive denomination are performed in one day, but *never* so as to cause pain. Either the animal is instantaneously killed by a puncture in the "medulla oblongata," and artificial respiration set up, or it is completely anæsthetised, and Prof. Schiff's first care is always to see that this has been properly done. The trial with the eyeball is a sure criterion. The anæsthetised animals are eventually killed in the same manner as the others, while still completely unconscious; few other dogs have such a painless death. In those cases where animals which have been operated on are kept alive for ulterior observations, the best proof that they do not suffer pain is the excellent appetite and healthy appearance of the dogs in the school of medicine here, where they are, moreover, excellently well-housed and fed, for Prof. Schiff says: "I like my dogs to be well cared for in every way." So much for the "horrible tortures" perpetrated on the continent.

I may be allowed to repeat a few words fallen from Prof. Schiff's mouth as characteristic of the man. On one occasion I heard him say: "I cannot bear the least pain being inflicted on animals;" on another, seeing me petting a dog which was to be experimented upon, he said: "one must never caress a dog before an operation, for otherwise, although one knows it feels no pain, one's hand is not steady for cutting."

It is true that there do exist experiments in which the animal must retain consciousness in order that the effects may be watched; but just because the animal would suffer pain, *these experiments are never carried out by Prof. Schiff.*

Prof. Schiff has repeatedly invited his calumniators (both publicly and privately) to come to his laboratory, which is open at every hour of the day to all who wish to form an unbiased opinion on the methods of vivisection, and to see with their own eyes the real facts of the case; not one has ever accepted this invitation—which shows how deep the love of truth is in some hearts. B.Sc., STUDENT OF MEDICINE

Geneva, April 6

Precious Coral

I WAS very much interested in Prof. Moseley's note on "Precious Coral," which appeared in NATURE (vol. xxv. p. 510). During, or rather after our deep-sea explorations in the Mediterranean, last summer, the *Washington* passed a week exploring the coral-yielding banks between Sicily and Cape Bon (Africa); we were also therefore on the coral-banks of Sciacca. Most of the coral I saw—I mean, of course, precious coral—was dead and blackened, and I saw large quantities in the same state, and from the same locality at Naples. At the extreme edge of the Sciacca bank is the extinct volcano, now covered with a few fathoms of water, known as Ferdinandea or Graham's Island. I believe that the eruption of that volcano may explain the quantities of dead coral around. As to the black colour, I am of opinion that it may be due to the decomposition of organic matter, rather than to the presence of binoxide of manganese; some of the bottom samples which I collected at various depths, turned quite black after a few weeks. The disappearance of the black colour on prolonged exposure to the sun, would, I believe, confirm my view. It must also be borne in mind that precious coral, in the Mediterranean at least, never is found in mud or in muddy waters, but grows mostly on a regular coral-rock formed by Madrepora of different species.

I have often heard of Japanese coral, and saw some fine samples at the International Fishery Exhibition of Berlin, in 1880; they came from Okinava, or Kotshi, where, in 1877, a quantity of the value of 9000 dollars was collected. It is this species which has been called *Corallium secundum* by Prof. Dana, if I am not mistaken.

A third species or variety of precious coral is found near the Cape de Verd Islands, especially San Jago; it has been distinguished by Prof. Targioni as *C. lubrani.*

As a *finale*, I may add that very little precious coral is found off Torre del Greco, from which place most of the coral fishermen hail, and in which place much of the coral collected is worked. HENRY HILLYER GIGLIOLI

R. Istituto di Studi Superiori in Firenze, April 6

Phenological Observations on Early Flowers and Winter Temperatures

THE relation of temperature to the earliness of the season is too obvious to be overlooked, but methods of representing it numerically are of considerable interest. Since 1878 this has been done for about thirty stations in the United Kingdom by

observations on the first appearance of a selected series of thirty flowers. The results have been published in tabular form in the *Natural History Journal*. Thus the means for all the 900 observations (thirty plants at thirty stations) give an accurate comparison of the relative flowerings in different seasons. The values for the four years (1878-81), reckoning in days from January 1, are 93, 115, 103, and 111, respectively, giving a mean date of 105·3. It will be seen that, when such observations have been conducted over a sufficient period, important values can be deduced as to the relation between the mean temperature and the mean date of flowering; that is, between temperature and vegetable growth. The comparison ought, probably, to be made with the mean temperature of the six months from December to May, the flowers having been chosen so as to be all out by or near the close of the latter month.

That December (if not November) should be brought in will be apparent from the comparison of warmth and flowers in the following table:—Here the *total number of flowers found in bloom* is compared with the mean temperature for the *four*, *three*, and *two* preceding months. The flower observations were made in the Christmas holidays, at Street, Somerset, chiefly by myself; a few, however, were by friends at Bridgwater twelve miles to the west. The periods were, for the four weeks beginning about December 15; but began a week later, and lasted only three weeks, in 1879-80 and 1880-81. For these years, therefore, an addition has been made of about one-ninth of the number actually seen (31 and 82); as comparison with other years shows that to be the proportion added in the fourth week. Again, in the first season, 1876-7, only 20 flowers were seen at Street, for I then had no idea of the numbers to be found by a little searching. The correction is made by comparison with Sidcot, in the Mendips, eighteen miles N.E., where for the four seasons, 1877 to 1880, respectively, 59, 62, 16, and 13 wild flowers were noted in January. Possibly, more experience would have slightly enlarged the garden list.

The *temperatures* are supplied by Wm. S. Clark, whose observations go back over twenty-five years.

Season. Dec. to Jan.	Weeks.	Flowers.			Mean temperature.							
		Garden (kinds).	Wild species.	Total.	In the weeks of observation.	Sept.	Oct.	Nov.	Dec.	In the preceding 4 mos	3 mos	2 mos
1876–77	4	67	20	120	42·3	57·7	53·6	43·1	43·3	49·4	46·7	43·2
1877–78	4	80	55	135[1]	39·8	52·2	48·8	45·4	40·3	46·7	44·8	42·8
1878–79	4	20	8	28	33·0	57·7	51·7	38·6	31·4	44·9	40·6	35·0
1879–80	3	21	10	34[2]	45·6	56·4	50·4	39·3	31·0	44·4	40·2	35·2
1880–81	3	45	29	82[2]	37·3	59·9	45·0	42·5	43·4	47·8	43·6	43·0
1881–82	4	101	88	183[3]	41·0	55·5	46·1	49·0	40·2	47·7	45·1	44·6

Now, on comparing these numbers, we find that the plant totals do not vary precisely according to any of the eight temperature columns, though closely related to the last. That is, the amount of early and late flowering is most affected by the temperature of the last two months in the year. In 1880-1, the number of flowers was reduced by the severe frosts early in January, which practically cut off the last week of observation. The large number as compared to temperature in 1877-8, appears to be explained by the regular decrease of warmth, without any great cold to cut off autumn stragglers. The comparative fewness of these in the present season (40 out of 88) should be ascribed to the abundance of new-comers.

That the weather *during* the period is of less effect than that of the previous months, is evident by comparing this season with 1879-80, when the three weeks were the warmest of any season under consideration.

We have already seen that the Sidcot observations confirm those at Street, the totals, though different, not varying very greatly. The same is true of observations in Devon and Cornwall, where in 1876-7 Mr. W. B. Waterfall observed 103 wild flowers (N. H. J., vol. i. No. 1), whilst this year Mr. Wm. Waterfall has kindly sent me a list of 119. Twenty-five fresh ones have been observed, although eleven others were not again recorded, "but they would no doubt be in bloom if looked for in the same locality."

[1] Corrected by comparison with the Sidcot list.
[2] Corrected by allowance of ⅓ for an extra week.
[3] Six flowers being contained both in wild and garden list, deduction is made in the total accordingly.

He also makes the following comparisons of date for four common flowers, to which I append the same, so far as recorded, for Street, Somerset.

	Devon and Cornwall.			Street, Somerset.		
	1876-7	1880-1	1881-2	1876-7	1880-1	1881-2
Hazel	Jan. 15	Dec. 18	Dec 26	Jan. 16	Jan. 1	Dec. 28
Celandine ...	Jan 16	Dec. 25	Dec. 25	Jan. 12	Dec. 25	Dec. 30
Ground Ivy...	Feb. 16	Dec. 25	Jan. 19	Jan.	Mar. 22	Jan. 31 (about)
Draba verna...	Jan. 4	Dec. 25	Dec. 12			Jan. 7
Average from Dec. 1	Jan. 18	Dec. 23	Dec. 28			Jan. 8

The comparative dates show even more clearly than the totals how remarkably forward the early part of the present season was compared with 1876-7, whilst the corresponding part of the foregoing season, previous to the severe weather, was still more advanced.

As regards classification, it is curious to notice that only three (wild flowers) were endogenous, the snowdrop and two grasses, *Poa annua* and *Triticum repens*. The following is a complete list under the various natural orders; S. stands for *Spring* blossom, R. for Remaniés (101 garden flowers were seen also).

EXOGENS.

Ranunculaceæ.
Anemone nemorosa, S.
Ranunculus acris, R.
,, repens, R.
,, bulbosus, R.
,, Ficaria, S.

Fumariaceæ.
Fumaria officinalis, R.

Cruciferæ.
Cheiranthus Cheiri, S.
Sinapis arvensis, R.
Arabis thaliana, S.
Barbarea vulgaris, R.
Nasturtium officinale, R.
Draba verna, S.
Capsella Bursa-pastoris, R. and S.
Senebiera Coronopus, R.
Lepidium campestre, R.

Violaceæ.
Viola odorata, S.
,, canina, S.
,, tricolor, R. and S.

Caryophyllaceæ.
Lychnis diurna, R. and S.
Cerastium triviale, R. and S.
Stellaria media, S.
,, Holostea, S.

Hypericaceæ.
Hypericum quadrangulum, R.

Malvaceæ.
Malva sylvestris, R.

Geraniaceæ.
Geranium molle, S.
,, Robertianum, R.

Leguminiferæ.
Ulex europæus, S.
Trifolium repens, R.
,, agrarium, R.

Rosaceæ.
Potentilla Fragariastrum, S.
Rubus fruticosus, R.
Prunus spinosa, S.
Fragaria vesca, S.
Geum urbanum, R.

Crassulaceæ.
Sedum acre, S.
Cotyledon acre, S.

Umbelliferæ.
Silaus pratensis, R.
Apium graveolens, R.
Heracleum Sphondylium, R.
Scandix Pecten-Veneris, S.
Conium maculatum, R. and S.

Araliaceæ.
Hedera Helix, R.

Rubiaceæ.
Galium Mollugo, R.

Dipsaceæ.
Dipsacus sylvestris, R.
Scabiosa arvensis, S.

Compositæ.
Silybum Marianum, R.
Chrysanthemum Leucanthemum, R.
Achillea Millefolium, R.
Senecio vulgaris, S.
,, Jacobæa, R.
Matricaria Chamomilla, R.
Bellis perennis, S.
Hypochœris glabra, R.
Leontodon autumnalis, R.
Crepis virens, R.
Hieracium umbellatum, R.
,, murorum, R.
Taraxacum Dens-Leonis, S.

Apocynaceæ.
Vinca major, S.
,, minor, S.

Scrophulariaceæ.
Linaria spuria, R.
,, Cymbalaria, S.
Veronica agrestis, S.
,, Buxbaumii, S.
,, arvensis, S.
,, serpyllifolia, S.
,, Chamædrys, S.

Labiatæ.
Stachys sylvatica, R.
Lamium purpureum, S.
,, album, S.
,, Galeobdolon, R.
Ajuga reptans, R.
Calamintha officinalis, R.

Boraginaceæ.
Myosotis arvensis, S.
Borago officinalis, S.

Primulaceæ.
Primula vulgaris, S.

Polygonaceæ.
Rumex obtusifolius, R.

Thymelaceæ.	*Amentiferæ.*
Daphne Laureola, S.	Corylus Avellana, S.
Euphorbiaceæ.	
Euphorbia Peplus, S.	ENDOGENS.
„ Helioscopia, S.	*Liliaceæ.*
Mercurialis perennis, S.	Galanthus nivalis, S.
Urticaceæ.	*Gramineæ.*
Parietaria diffusa, R.	Poa annua, S.
Urtica urens, S.	Triticum repens, R.

In conclusion, my object in presenting these notes to your readers is threefold; first, to suggest an agreeable, easy, and yet useful occupation for winter walks; second, to indicate the value for phenological purposes if a great number of such series of observations could be made for a long series of years at various parts of our country; third, to show how great is the difference, even within the limits of the British Isles,[1] in the time of flowering of common plants, and yet how little we know upon the subject. Should any desire to assist in work of this kind, I would gladly forward free a copy of our printed form, containing lists and suggestions for observations, both of flora and fauna. The work is carried on in connection with the phenological branch of the Meteorological Society, of which the Rev. T. A. Preston, M.A., of Marlboro', is the efficient Secretary.

Bootham, York J. EDMUND CLARK

[1] At Wigton, Cumberland, for instance, although on the West coast, Mr. J. E. Walker noticed only *fourteen* wild flowers.

Colours of Low-growing Wood Flowers

NO one can enter our English woods just now without being struck with the lovely way in which they are starred with the yellow of the primrose, the white of the anemone and strawberry, and the light blue of the dog violet. It will be noticed that the tints of these flowers seem positively to shine in the low herbage and among the semi-shade of the trees and bushes. After twice going through the descriptions of flowers growing in similar situations, given in Hooker's "Student's Flora of the British Islands," I find that nearly all our dwarf wood flowers are white, light yellow, and light blue. None appear to be red. Three are purple—one form of the Sweet Violet and the Ground Ivy (*Nepeta Glechoma*), both of which are scented; and the Bugle (*Ajuga reptans*).

If the white and yellow tints of flowers fertilised by night-moths are of service in guiding the moths to them, may not the like tints in low plants in thickets and woods be similarly advantageous to the plants by tending to secure fertilisation? The more lordly foxglove, the ragged robin, and other higher growing flowers, erect above the low herbage, and enjoying more light, are conspicuous enough, but how would a small flower of the colour of a foxglove attract attention when hid among the grass? The purple of the bugle I cannot account for. The ground ivy has a pungent scent. The purple of the sweet violet is certainly inconspicuous, but here the scent may be the attraction, or the habit of the plant in forming cleistogamous flowers, may secure its multiplication. Hence it may be questioned whether the white form of the sweet violet does not mark a gradual transition towards that colour. If the white forms are more conspicuous, and ecure easier cross fertilisation, they may in time preponderate. Perhaps the existence of the sweet violet in the purple and in the white form may throw light on the origin of the general lightness of tint in dwarf wood subjects.

The low flowers in dark places which were lighter and made themselves best seen, would more readily secure fertilisation, and through natural selection would tend to have still paler tints. The change might be aided by the bleaching of flowers in shade, as described by Mr. J. C. Costerus (NATURE, vol. xxv. p. 482). In this connection it may be noted that the wood anemone has a rare purple form—perhaps a survival—and that *Anemone Apennina* is light blue. The Potentillas, close allies of the strawberry, but mainly growing in the open, have as a rule yellow flowers; sometimes red ones. The various mountain primroses of this and other countries, and those that grow in meadows (like our own Bird's Eye Primrose, *primula formosa*), have mostly reddish, lilac, or rosy flowers. The common primrose, when growing in exposed hedgebanks has often reddish, lilac, or purple flowers. Its sports in cultivation are often white, so it may be progressing towards that tint in woods. The cowslip, which grows in meadows, has a deeper tinge of yellow than the oxlip, which grows in copses. The cowslip is also far darker than the primrose, and sometimes has a scarlet or orange-brown corolla—perhaps the germ of the dark rich polyanthus of our gardens. The primrose family may have originated in woods, and have been originally light, gradually darkening as the flowers multiplied in the open; or, which is more probable, the tribe originated in exposed situations, creeping by slow degrees into the woods, and bleaching as it went.

Bexley, March 30 J. INNES ROGERS

Vignettes from Nature

MR. BUDDEN is perfectly right in querying the locality of the specimens of sharks' teeth which I mentioned as having seen from a South American digging. In consequence of a slight deafness, I misunderstood my friend's account of them; and knowing them to be American, assigned the word "South" to "America," instead of to "Carolina," in the coprolite pits of which they were found. WILLIAM B. CARPENTER

ECONOMIC GEOLOGY OF INDIA[1]

II.

IN a former notice of Prof. Valentine Ball's important work on the "Economic Geology of India," the subjects of the gold supply and of that form of carbon known as the diamond, were treated of. In the present notice it is proposed to give a brief account of that more important form of carbon known as coal, as well as to allude to the valuable information given in the chapters on Iron, Salt, and Building-stone. The rocks, which in Peninsular India probably correspond, as regards the time of their formation, to the true carboniferous rocks of Europe, are not coal-bearing, and the oldest coal-measures in the country belong to a period which is well included within the limits of the Upper Palæozoic or Permian, and the Lower Jurassic formations. All the useful coal of the peninsula may conveniently be described as being of Permio-Triassic age, and, with two exceptions, it may be added, these measures do not occur beyond the limits of the peninsula. In the extra-peninsular area, coal is found in various younger deposits, and there are numerous deposits in Afghanistan, the Punjab, at the foot of the Himalayas, in Assam and Burma, of undoubted Lower Tertiary, Nummulitic, or Eocene coals and lignites; but it is only quite exceptional that such deposits possess any great value (the chief noteworthy exceptions occur in Assam and Burma).

According to the somewhat liberal estimates of Mr. Hughes, the areas in India, in which coal-measures occur, including those unsurveyed, amount in all to 35,000 square miles, but the thickness of a vast number of the seams of coal in these basins is very varied. For over one century the coal-mining industry of India has been in operation, and there has been a steady increase in production and consumption, especially within the last ten years. Still the coal resources of the country cannot be regarded as yet developed. Out of over thirty distinct coal-fields in Peninsular India, only four or five are worked at all, and even of these, but two have arrived at an output of from 1 to 2000 tons a day, and this though in these two fields the coal-pits are numerous.

It is very important that the reasons for this state of things should be well understood, and they are not far to seek. Most of the coal-fields are very remote from the centres of manufacture and from the seaports, and at these places the native produce has to compete with a better quality of coal sea-borne from Europe. With the extension of railways in India, the home coal will have a better chance, as the facilities of carriage will enable the coal to be brought to the iron-mines, which are mostly too at long distances from the ports, and when used in the reduction of metallic ores, the demand for coal would increase.

[1] "A Manual of the Geology of India. Part III. Economic Geology." By V. Ball, M.A., F.G.S., Officiating Deputy Superintendent, Geological Survey of India. Published by order of the Government of India. (Calcutta, 1881.) Continued from p. 510.

As to the quality of the coal of Peninsular India, it is not easy to write in general terms. It may be described as a laminated bituminous coal, in which bright and dull layers alternate; much of it does not coke easily. No true anthracite has as yet been discovered. In the coal from the Raniganj field, the proportion of fixed carbon is under 55 per cent., which is about 10 per cent. under that from the Karharbari field. The amount of moisture varies a good deal in the coal from the different fields, being as high as 14 per cent. in the coal from the Godavari field, and not more than 5 per cent. in that from the Raniganj field. The quantity of sulphur and phosphorus present varies also considerably, but coal, sufficiently free from these impurities as to be available for the manufacture of steel, is to be found. In a table showing the amount of coal imported into, and raised in India, for the years from 1852 to 1880, we find, that of a probable total amount of mineral fuel consumed in India during 1880-81, of 1,500,000 tons, one million was raised in the country, and half a million was imported. While the price of European coal at Indian ports varies, the average value at present per ton is about 30*s*., and English coal has been sold within the last ten years, in Calcutta, for as small a sum as 15*s*. a ton.

At the pit's mouth at the Raniganj field the value of the best coal is about 5*s*. a ton, but the same coal in Madras costs from 30*s*. to 32*s*. a ton, the difference being the cost of transit. On many of the railways in Upper India, wood is largely used as fuel, being much cheaper than coal.

The largest and most important of the areas in which coal is worked in India is that of the Raniganj field. It is situated on the rocky frontier of Western Bengal, at a distance of 120 miles from Calcutta. The available coal was calculated in round numbers by the late Dr. Oldham to be 14,000 millions of tons. Its proximity to the main line of railway, and also to the port of Calcutta, give it an advantage over all other coal areas in India. Coal was known to occur there in 1774, and so long since as 1777 was actually worked. There are now five European companies engaged in the extraction of the coal, besides many smaller firms, and one native company. At one time a good deal of the coal was obtained by open quarrying, now mining is adopted on the pillar and stall plan. None of the mines are of great depth; and there is a perfect freedom from fire and choke-damp. Some of the seams are nearly forty feet in thickness, but as a rule the very thick seams do not contain the best quality of coal. The Lieut.-Governor of Bengal reported for the year 1878-79, that "the year was a prosperous one for the coal companies of Raniganj. There was a large demand, and production was greatly stimulated. The output is estimated to have been 523,097 tons, against 467,924 tons, the average of the three previous years. The number of persons employed was 388,931 men, 194,647 women, and 27,277 children."

The coal-supply of India is a subject of vast interest, one full with a great future for India, and one which though slowly, is steadily coming to be properly understood.

Into the subject of "Peat in India" the space at our disposal does not allow us to enter; and that of "Petroleum" can only be glanced at. So far as is at present known, petroleum has not been met with within the limits of Peninsular India. In the extra-peninsular countries there are several regions where the strata yield more or less abundant supplies of petroleum. The most important of these are in Burma. In British Burma the working of the oil springs is but in its infancy. But in Upper Burma, the exportation of the rock oils is said to have been in progress during the last 2000 years. The oil of Upper Burma, commonly known as Rangoon oil, is a valuable article of export, taking its name from the port from which it is shipped to Europe and America.

In intimate connection with the Coal of India is the abundance in extent of the Iron ores of the same region. In the peninsular area, magnetite occurs in beds or in veins of greater or less extent in most of the regions where metamorphic rocks occur. In some places, as in the Salem district in the Madras Presidency, the development of this ore is on a scale of extraordinary and unparalleled magnitude, whole hills and ranges being formed of the purest forms of it; and in many cases these deposits are not lodes, but beds as truly such as those of gneissose and schistose rocks, with which they are accompanied. To the abundance and wide-spread distribution of these ores in the oldest rocks is no doubt to be attributed the fact of the frequent recurrence of considerable deposits of the general dissemination of ferruginous matter, which more or less characterise the sedimentary rocks of all subsequent periods. In some localities bedded magnetite is known to occur in sub-metamorphic or transition rocks. Thus the rich ores of Central India are principally found as hæmatites in the Bijawar or lower transition series of rocks.

The prevailing red and brown tints characterising the great Vindhyan formation are owing to the presence of iron ores in veins. The Talchir group of the Gondwana system—supposed to have been deposited from floating ice—is notable for the absence in it of iron matter. The next group Barakar is also almost free, but with some remarkable exceptions, as, for example, in the vicinity of the Aurunga coal-field at Palamow. The third group of the system is one of iron-stone shales; while in the succeeding members of the group iron is, though somewhat unequally distributed, always present.

The Laterite of India is peculiarly rich in iron ores, and these have been worked by the native smelters time out of mind. Practical men have sometimes spoken of the native furnaces and methods of working in a very contemptuous manner, or have regarded them as merely objects of curiosity, but ought this to be so? Does not such a work as the famous iron pillar at the Kutab, near Delhi, indicate an amount of skill in the manipulation of a large mass of wrought iron, which has ever been a marvel to all who have studied it. But a few years ago, what iron foundry in Europe could have produced the like, and even now how many are there that would turn out such a mass? Of a total length of 23 feet 8 inches, just 22 feet thereof stands exposed over the ground. Over 16 feet in diameter at the base it tapers to a little over a foot just below its capital, which is $3\frac{1}{2}$ feet high. Its total weight is over six tons. Mr. Ferguson, in his "History of India," believes from the letters on the inscription that it dates from A.D. 400; if so, then it has stood exposed to wind and weather for nearly 1500 years, showing no signs of rust; a most complete testimony to the skill and art of the Indian iron-workers of the period.

Even in quite recent days Indian steel was in considerable demand in England. Its production was the cause of much wonderment, and was accounted for by various theories. The famous Damascus blades had long attained a reputation for pliability, strength, and beauty, ere it was known that the material from which they were made was the product of an obscure Indian village, and it is probably not very generally known that a large quantity of the excellent iron used in the construction of the Menai Suspension and the Britannia Tubular Bridges, was from the Porto Nevo Works in South Arcot in Salem district. The competition with European iron has practically thrown the production of native ore into the deepest shade. Unless, indeed, the Indian iron factories should succeed in producing iron at so low a rate as to defy competition, the import of European iron must continue with the result of leaving no margin for profitable working. In England, too, it will be remembered that the demand for skilled labour has brought forth an abundant supply. In India the loss of a life, or a stoppage of machinery may be productive of serious and prolonged delay, causing numerous embarrassments.

It would seem almost too late for the Government of India itself to undertake the manufacture of iron. Perhaps had it done so, prior to the opening up of its fine system of railways it might have done good, keeping money in the country and employing labour, but there were many and serious objections to such government establishments. In the meanwhile, here and there throughout India iron is still manufactured.

The earthy varieties of the hæmatites, or red and yellow ochres, are abundant in India. They are used by the natives as mineral pigments under the collective term of *girn*, for the adornment of the walls of houses and huts, and sometimes to make the caste marks on the foreheads of the Hindus.

In the Gabalpur district a paint is manufactured by grinding the ore to an impalpable powder by means of grindstones worked by small water-wheels. The powder is packed in bags, and sells retail at a price so high as 13*l*. a ton. It has proved to be the cheapest paint in the Indian market. It lies smoothly on wood or iron, and has been successfully used against damp or porous tiles, bricks, and plaster. It has already stood a good practical test on the metal work of the principal bridges in India.

So far as the coal and iron products of this great dependency of ours are concerned, they would seem more than sufficient for all her needs, but at prices that were alone remunerative when the country remained isolated from the rest of the world. By competition the native production has been almost starved out, but the native consumers get as good an article, and at a far cheaper rate now than of old.

Salt is the mineral product of all others, the most important to the revenue of India, the gross annual receipts from the salt-tax being now about seven millions of pounds sterling. While the native supply is practically inexhaustible, there is still a steady import trade from foreign countries. Within the last ten or twelve years, a great deal has been done in the way of equalising the salt-tax in the different districts of India, and the Government monopoly is now fairly complete. In Madras the indigenous sources of supply have been the salt-pans on the coastal districts, where salt is obtained by the evaporation of sea water. It was also obtained at one time by the lixiviation of saline earth. The salt manufacture begins in January, as soon as the rains are over and the weather begins to get warm. Before the evaporation at the pans begins, there is a preliminary evaporation, lasting over some twenty-five days, in pits, by which the brine is reduced 50 or 75 per cent. in bulk. The manufacture in the pans continues for about twenty-nine days, when the salt is taken out and stored on the banks to dry. The brine is not evaporated to dryness in the pans, in order that the magnesium sulphate may, as much as possible, remain in solution. In Rajputana, there are four sources of salt. The most extensive are the salt lakes, such as Sambhar and Didwana; next come the brine-pits, then some salt is obtained from saline efflorescence from earthwork, and some from deposits in old river-pits. A brine-pit in Bhartpur, examined in 1865, contained 20 to 30 feet of brine at a depth of 20 feet from the surface, and was reported to have shown no diminution of supply during the preceding twenty-eight years.

The Punjab is distinguished from all the other districts of India, in possessing enormous deposits of rock-salt, and it is very remarkable that these deposits do not all belong to the one geological age, but are referable to very distinct periods which are widely separated in time. During the year ending March 31, 1880, inland customs duty was paid on 55,000 tons of salt from the rock-salt mines of the Punjab. The rock-salt of the Kohet district would seem to be of Eocene age; it is overlaid conformably by gypsum, which is again overlaid by rocks of Nummulitic age. Here the salt is obtained by open quarrying. The quarries at Malgin have been worked from time immemorial; those at Bhadur Khel were opened some twelve centuries ago. The total available quantity of salt in these quarries has been estimated to afford a supply, which, allowing a liberal margin for waste, would, at the rate of the present demand, last for 4000 years.

The Salt-range deposit is the oldest-known deposit in the world. It underlies beds containing Silurian deposits, and is therefore of a period at least not younger than the Silurian age. The rock-salt in this range is worked underground. The largest mines of the range are the Mayo mines at Khewra, on the eastern side of the Indus. These and the neighbouring mines had been worked most of all, and generally on a most dangerous system. Thus, in one of the Mayo mines the old Sikh workmen having worked out the salt in one vast chamber, the roof of which which was supported by two immense pillars, commenced and worked out a second chamber under the first one, and beneath the pillar supporting its roof, with the result that on a Sunday, in June, 1870, one of these pillars broke through, carrying with it a large part of the roof, and forming a crater on the hill where the mine is situated. Since then, these mines have been worked in accordance with modern principles, and the appearance of their tunnels, drifts, and tramways is most imposing. There is even a wire-rope tramway to the nearest village from the mouth of the mines. The annual average receipts from the Salt-range Mines is 388,144*l*.

In connection with salt, the subject of Reh is a highly important one. *Reh* is the native term applied to efflorescent salts which have accumulated in the soil or in the subsoil waters of large tracts in India, and this, in some places, to such an extent that cultivation has become impossible, and fertile fields have become barren spaces. The origin of this Reh is now fully understood; the rivers carry in solution saline particles washed out of the rocks over which they flow; as well as a fine silt or alluvium, which also, on its decomposition, yields further salts; in a region of intense evaporation, and where the surface of the ground is constantly irrigated, if there be no free drainage outlet for the waters, the salts contained in them are accumulated in the soil, or still further surcharge the subsoil waters; while over and above all this, during the rainy reason the rain-water, charged with carbonic acid, falling on the porous soil, has the effect of decomposing its mineral constituents and of carrying down to the subsoil the salts then formed. This being the state of things, when the surface of the ground becomes dried, the water, charged with salts, rises up and evaporates, leaving a salt efflorescence, the *reh*, which at length so permeates the superficial layer of soil as to leave it little better than a salt marsh. Contrary to what might on first sight be expected, irrigation by even pure canal water seems to increase the evil; for, as Mr. Medlicott has so well pointed out, the table of salt subsoil water is, by the addition of the canal water, raised to a height that brings it within the reach of evaporation; and so the efflorescence is increased. The only remedies for this state of things would seem to be good, deep subsoil drainage, with thorough washing of the surface soil, and protecting the latter as much as possible from evaporation.

India at one time enjoyed almost a monopoly of the saltpetre trade, and even still, from the port of Calcutta, in the year 1879-80, the export of this commodity was nearly 432,000*l*. The peculiar habits of the people and the fact that in the saltpetre- roducing districts there is a long period of drought after a long period of rain, accounts for the soil in the vicinity of the Indian villages being impregnated with this salt. More than two-thirds of the total quantity of the saltpetre which is exported from Calcutta at present comes from the districts of Tirhut, Saran. and Champaran in Behar.

The Building Stones of India form a wonderfully interesting subject. Among the most abiding records of any

nation must always be included the buildings they have raised, and the duration of these will depend on the material chosen for the erection. Is it a necessity of modern civilisation that our great edifices should be constructed of materials that are quick to perish? and why should it be said of Anglo-Indian architecture, that if the English left India, in a century after their departure no sign of their occupation would remain? and in India, as Prof. Ball remarks, unlike new countries such as Australia and most parts of America, where knowledge had to be obtained by experience, the native temples and buildings should have at once furnished the needed information as to the durability of the material used in them, the only one quality in building material that nothing save time is a test for. Most of the buildings erected by the British in India are built of brick; it need scarcely be added that all the native temples are of stone, and that many exhibit a wonderful mastery over sometimes difficult material. Very strange is it, too, to learn that the resources of India in this respect are so little known or appreciated, that at this day advertisements daily meet the eye in the Indian papers of Aberdeen granites and Italian marbles; and yet how many temples are there to be found in India, constructed of native granites? and what can surpass the white marble filigree screens called jalee, made out of the native marble?

One splendid screen is thus described by Mr. Keene: "But all the marble work of Northern India is surpassed by the monument which Akbar erected over the remains of his friend and spiritual counsellor, Shekh Sulim Chisti, at Fatipur Sikri (1581 A.D.). In the north-western angle of a vast courtyard, 433 feet by 366 feet, is a pavilion externally of white marble, surrounded by a deep, projecting dripstone, also of white marble, supported by marble shafts, crowned by most fantastic brackets, shaped like the letter S. The outer screens are so minutely pierced, that at a little distance they look like lace, and illuminate the mortuary chapel within with a solemn half-light which resembles nothing else that I have seen."

The varieties of metamorphic rocks suited to building purposes in India are very numerous; besides the granites, sandstones and porphyritic gneiss abound. In Mysore, a building-stone occurs in the crystalline rock of the district, which can be split into posts twenty feet long, which have been used for the support of the telegraph wires; and the peculiar adaptability of gneiss to fine carving is often to be seen in the rings appended to the drooping corners of some of the pagodas, where the rings, the links within which are movable, and the projecting corners, are carved out of a single block. Among all the formations, the Great Virdhyan sandstones stand prominent; these were used in the manufacture of stone implements; the great memorial monoliths or lats, many of which bear the edicts of Asoka, the protector of the early Buddhists who reigned about 250 B.C., are made of this stone; some of these are of great size, and on the exposed surfaces are polished; their carved capitals were surmounted with figures of lions or elephants.

There are many quarries of stone throughout India, opened in these Vindhyan rocks. At Dehri, on Son, the stone is a compact white sandstone, strong and durable, and susceptible of artistic treatment. Other fine quarries are at Chunar, from which has come for ages the supply to Benares and Calcutta. But perhaps the most important quarries in India are those in the Upper Bhanrers, whieh have furnished building material since before the Christian era, to the cities of the adjoining plains. Portions of the Taj at Agra, Akbar's Palace at Fatipur Sikri, the Jamma Masjid at Delhi, have been built from the stone of these quarries. The palace of the Rajah of Bhartpur, at Deeg, one of the most beautiful edifices in India, is constructed of the stone from the same district. In it, cupolas rest on slender shafts of two or three inches in diameter. Arches are supported on strong, yet graceful pillars, and windows are formed of single slabs of stone, perforated with the most elaborate tracery.

Among the sandstones of the Damuda series, there are several varieties which are suited for building purposes. Throughout the Damuda valley, where these rocks occur, they have been used from considerable antiquity for the construction of temples. Among the finest examples known, some Jain temples at Barakar may be mentioned, as they exhibit specimens of wonderful carving which has stood well, though the old Pâli inscriptions on stone of this material in the caves of Sirguja and Chang Bakhar even better testify to the endurance of this rock.

Laterite has also been used as a building material, but it is not ornamental, and does not weather well. Good roofing slate does not appear to exist in India, though in the transition rocks of the Kharakpur Hills, slate occurs; it is a partially altered earthy rock, which is readily fissile, and with pains and care can be reduced to a thickness of one-eighth of an inch; it would answer well for flagging.

Extended though this notice of Prof. Ball's book has been, we have been unable therein to glance at more than its more prominent features. We doubt not, however, that the reader will perceive that it is one of the most important contributions yet made to our knowledge of the economic geology of this vast kingdom, the prosperity of which so nearly and so intimately concerns ourselves.

THE SCIENCE AND ART DEPARTMENT

WE have received the following communication from a correspondent:—

There are few Blue Books that better repay careful study than the admirable reports of the Science and Art Department. The Twenty-eighth Report has recently been issued, and is of exceptional interest. Its bulky appendices contain, as usual, a mass of valuable statistics relating to the diffusion of scientific and artistic instruction among the masses; and in the body of the report we find indications of a general scheme of reorganisation, both in the details and the scope of the higher scientific education given in the Science Schools at South Kensington. This scheme has now taken definite shape, and came into operation with the session which has recently opened. It is therefore a fitting opportunity briefly to review the work done by the Science and Art Department in the scientific instruction of the people, and then examine the nature and object of the changes that are being made at South Kensington.

The Great Exhibition of 1851 revealed the fact, that in order to compete with the industries of foreign nations, it was imperative to have artistic and scientific instruction more widely diffused among the middle and lower classes of this country. To accomplish this the Science and Art Department was formed, and to the soundness of the principles laid down by the Prince Consort and the genius and labour of Sir Henry Cole the success of this Department is largely due. This success is not merely to be found in the large numbers attending the classes in connection with the Department; it is to be seen in the growth of artistic and scientific knowledge among the people, and the application of that knowledge to industrial pursuits. A striking testimony of the change, mainly wrought by the Department, is to be found in the report of the French jurors in the last general Exhibition at Paris. This report states:

"English industry in particular, which, from an artistic point of view, seemed greatly in arrear at the Exhibition of 1851, has during the last ten years made amazing progress; and should it continue to advance at the same rate we might soon be left behind. This state of things

appears to us to merit the most serious attention of the French Government and manufacturers."

The Department had nevertheless to encounter a bitter and unscrupulous opposition in various quarters, and being less anxious to answer its detractors than to do the work intrusted to it, sneers about South Kensington became easy, and a clap-trap denunciation of the Brompton clique went the round of society, and is even now to be found among its dregs. Though for many years the object of persistent and venomous attacks, Sir H. Cole, never swerved from the great work commitfed to his care, and England is now beginning to recognise the debt of gratitude she owes to this truly remarkable man.

And now let us look at the method of encouraging elementary scientific instruction adopted by the Department, and at some of the results of its methods.

The system of certificated science and art teachers was introduced, with payments to both teachers and pupils dependent on the results of an annual examination in May. By this means pupils were attracted from the artizan class, and teachers were glad to have pupils at almost a nominal fee. Through evening instruction alone a moderate income could thus be made by any active and painstaking teacher who complied with the rules laid down by the Department. In this way, irrespective of fees, the teachers of the Science School at Keighley received last year in payments on results nearly 350*l*.; the teachers at the Bristol Trade and Mining School, in the same way, made upwards of 450*l*.; the teachers at St. Thomas, Charterhouse, nearly 600*l*.; and the teachers at some of the Science classes in Liverpool nearly 700*l*. Similar results are to be found among the certificated art teachers. It is not surprising that the number of schools in connection with the Department rapidly and steadily increased, till in 1870 there was only one short of 800 science schools, with the large number of 34,283 students under instruction, chiefly during the evenings of the week. Ten years later, in 1880, these numbers had increased nearly 60 per cent., there being now 1391 elementary science schools under the Science and Art Department, with 60,871 individuals under instruction: 34.678 of these students entered for the annual examination in May, several taking two or more subjects, so that there were over 69,000 papers worked; of these upwards of 45,000 were passed, or more than 65 per cent.; and 12,000 gained a first-class, or say 27 per cent. of the successful papers. Every successful paper entitles the candidate, if in the first division, to a prize, and the certificated teacher to a money payment.

As might be expected, the inhabitants of the manufacturing districts avail themselves most largely of the May examinations; and it is instructive to note the relative number of individuals receiving elementary science instruction in the different sections of the United Kingdom. Last year there were in *England* 42,711 students, who paid in fees 8963*l*., or a little over 4*s*. each; and gained 7281 prizes and medals, or about one prize to every six students. In *Wales* there were 1344 students, who paid in fees 146*l*., or a little over 2*s*. each, and gained 184 prizes and medals, or one prize to every seven students.

In *Scotland* there were 7376 students, who paid in fees 2088*l*., or 5*s*. 9*d*. each, and gained 1423 prizes or medals, or one to every five students; in *Ireland* there were 5369 students, who paid 665*l*. in fees, or 2*s*. 5*d*. each, and gained 1267 prizes and medals, or one to every four students. The payment on results to the teachers amounted to 29,900*l* for *England and Wales*, or say 14*s*. per pupil, to 5250*l*. for *Scotland*, or 14*s*. 2*d*. per pupil, and to 5079 for *Ireland*, or 18*s*. 9*d*. per pupil. The foregoing analysis which we have made of the figures in this report shows that Ireland has the highest proportion of prize-winners, indicating a higher grade of ability on the part of both teachers and pupils; at the same time its students are poorest, or at any rate least inclined to pay for instruction. The smallness of the fees received by the teachers doubtless also acts as a stimulus to the teacher, for it makes his payment almost wholly dependent on the successes of his pupils.

The report unfortunately does not supply any data as to the relative number of boys and girls among the students, an omission that we hope may be supplied in some future reports; for the Department had the honour of recognising the claims of women to educational prizes and distinctions long before any University opened its door to women.

The nature of the subjects selected by the students differs considerably. The following table, which we have summarised from the report, shows a singular and suggestive difference in national traits; the figures indicate the number of individuals under instruction in 1880:—

	Geometrical drawing	Mathematics.	Mechanics.	Physics.	Chemistry.
England and Wales	17,494	11,081	4,293	15,401	7,732
Scotland	2,229	3,050	1,226	1,477	1,475
Ireland	292	2,738	982	3,212	439

	Geology.	Biology.	Steam.	Physiography.	Agriculture.
England and Wales	2,092	9,336	1,539	4,435	2,772
Scotland	416	935	539	709	548
Ireland	406	821	105	1,521	3,104

It will be seen from this that in England the majority select geometrical drawing, next to that physics, and then mathematics. In Scotland the majority choose mathematics, and next to that geometrical drawing; very few selecting agriculture. In Ireland the majority select physics, and almost as many agriculture; next to that being mathematics, and very few geometrical drawing.

In connection with these statistics we notice that Ireland stands far below England and Scotland in point of the number of its art schools and art students; and this notwithstanding that the Irish are essentially an artistic race, the fame of many Irish artists being well known. In fact, though the number of art students in Ireland is small, the quality of their work is more than twice as good as English or Scotch art students; that is, judged by payments on results, the payment to pupils in English art schools under the Department average in the annual competition about 2*s*. 3*d*. a head, in the Scotch 2*s*. 4*d*., in the Irish 5*s*. In round numbers, there are in England about 5000 art schools, with some 650,000 pupils; in Scotland there are more than 500 art schools, with some 75 000 pupils; whilst in Ireland there are only 50 to 60 art schools, with 6000 to 7000 pupils. In fact few things are more needed in Ireland than the encouragement of art-teaching by local art, by museums, and otherwise; and now that the difficulties and interminable correspondence between the Royal Dublin Society and the Department are at an end, we have no doubt that the able and energetic director of the national collection in Ireland will make this question an object of care.

If we now turn to examine the percentage of failures in the different subjects taught by certificated science-teachers, we find some surprising results. Not only is there a wide difference in the number of failures in the different subjects, but in the same subject the percentage varies extravagantly in different years. We cannot think this is wholly, or even chiefly, due to the candidates, the variations seem far more likely to be due to differences in stringency on the part of the examiners. Uniformity is

of course impossible, but a greater unity of action on the part of the Board of Examiners seems necessary. Take, for example, geometrical drawing: there were 39 per cent. of failures in the elementary stage in 1879, and 50 per cent. in 1880. In botany there were 43 per cent. of failures in 1879, and 20 per cent. in 1880. In biology there were upwards of 40 per cent. of failures in 1879, and only 17 per cent. in 1880. In sound, light, and heat 51 per cent. of failures in 1879, and 35 per cent. in 1880. Magnetism and electricity on the other hand, is extremely uniform, having 29 per cent. of failures one year and 30 per cent the next. But if we look at the advanced stage for 1879 the failures vary from 25 per cent. in magnetism and electricity to 60 per cent. in botany, and 82 per cent in biology. These fluctuations, if due to idiosyncrasies on the part of the examiners, are very serious for the teachers who are dependent for their livelihood on the payment by results. The natural result is the teacher selects that subject wherein he thinks there is least chance of failure, and thus we find the number of papers worked in the different subjects follows very closely the ease with which a candidate is likely to pass.

Then, as to the method of examination. Would it not be possible to introduce a *practical examination* in physics as well as chemistry? The additional expense might in part be met by imposing a small fee for examination, and only those students should be eligible for the practical examination who have passed in the "advanced" stage. A certificate for practical knowledge in special branches of science would be most valuable to its holders, and no teacher should be allowed to obtain payment on results until he has one of these certificates. At present any one with very elementary knowledge indeed can set up as a teacher, and the value of the title "Certificated Teacher under the Science and Art Department" is not what it should be. Moreover, a preliminary examination in writing and spelling, and perhaps elementary drawing, ought, we think, to be passed by every certificated teacher. Again and again has the present writer had the most atrocious spelling and writing, to say nothing of English grammar, come under his notice in the May Examination Papers; and yet if the student answered the questions before him he was bound to obtain a certificate, and would doubtless be a full-blown certificated teacher, with a class of pupils, before the year was out.

To meet the need of practical teaching, the Department has lately taken a most admirable step in advance. An arrangement has been made whereby a certain number of carefully-selected teachers have the opportunity of coming to London during the summer vacations, and spending a month to six weeks in the practical study of certain branches of science under the direct personal guidance of the eminent professors at the South Kensington Science Schools. In this way, year by year, from twenty to fifty teachers avail themselves of invaluable instruction in chemistry, physics, mechanics, geology, botany, and agriculture. A number of teachers (some 65 out of 200 applicants) are admitted free to the regular courses of instruction at South Kensington. Furthermore to meet, what to many certificated teachers would be the prohibitive expense of coming to London from the provinces, Government pay their railway fare to and fro, and give them an allowance for board whilst under instruction at South Kensington.

And just in passing we may perhaps ask how it is the Treasury have sanctioned the expense of paying the yearly contingent of Irish teachers going the long distance to and from London, when in Dublin there is a School of Science under the Department equipped with an even larger staff than at South Kensington, and furnished with quite as extensive and as admirable educational appliances? This is just one of those points which are calculated to wound the susceptibilities of Irishmen and to foster the cry for local self-government. Moreover, the claims of the College of Science to take part in the training of assisted teachers become still more evident when we find that there are in England thirty-three training colleges receiving grants from the Department, whilst in Ireland there is not one. We feel, however, that attention has only to be called to this point to lead to some change, if there are no insuperable obstacles in the way.

To return—the need for, and the success of, the scheme for training teachers has led to an important alteration in the scope of the Science Schools at South Kensington. This session it begins its work under the title of the "Normal School of Science," added to that of the Royal School of Mines. As before, Diplomas of Associate are given to those students who successfully pass through the prescribed curriculum, but considerable changes have been made in the curriculum. A student can now gain the title of Associate of the Normal School of Science if he passes successfully in one or more of the following divisions:—(*a*) Mechanics, (*b*) Physics, (*c*) Chemistry, (*d*) Biology, (*e*) Geology, (*f*) Agriculture, and he can gain the Associateship of the Royal School of Mines in (*g*) Metallurgy and (*h*) Mining. The course of instruction is the same for all divisions during the first two years, after which it is specialised in accordance with a carefully-prepared scheme. At least a three-years' course is therefore necessary for all candidates for Associateship, the fees amounting for the first two years to 75*l*., and for the remainder of the time vary from 30*l*. to 40*l*. There are, however, several scholarships and free studentships open yearly to competition.

And now we must close this lengthy review. To those who have followed the work already done by the Department of Science and Art, and even to those who, ignorant of it, have troubled themselves to read this article, it must be evident that the anonymous croakers at South Kensington are merely enjoying the English privilege of grumbling, and are doubtless secretly proud of this important Government Department.

AN ELECTRIC BAROMETER

NOTICING an account of a new electric barometer, brought before the Royal Scottish Society of Arts, which requires some fifty communicating wires, and reads but to the one-tenth of an inch, I venture to send the following. It aims at solving the problem—that of reading a barometer, placed at a distance from an observatory—in a more simple manner.

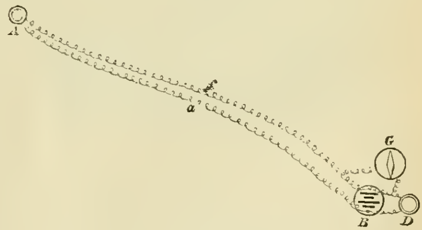

Fig. 1.

The barometer, the height of which is to be ascertained, has two platinum wires fused through the glass, at the vacuum end of the tube. One of these is continued by a stout iron wire, the other by a fine carbon thread, both of which are joined at a point in the tube below the level of lowest fall. The iron wire keeps the carbon filament vertical and central in the tube. From the platinum ends outside, wires communicate with the observatory; and a current passed through them traverses both iron and carbon in its passage.

Now, the carbon being a substance of high resistance, a very small change in its length will tell on the potential of the returning current: its effective length, however, varies with the level of the mercury, and the object in view is to measure the movement in the barometer by the potential of the returning current. And, in the first place, what is the theoretic sensitiveness to be expected?

Taking the conductivity of copper as 100, that of carbon is about 0·07; and supposing eight miles of copper wire in circuit (barometer being four miles from observatory), and that a wire of one-eighth inch diameter be used; supposing, also, that the carbon filament be of one-fiftieth inch diameter; then the following is the result arrived at:—For a rise of the mercury of one-fiftieth of an inch, the resistance is lowered 1-455th. Closer readings would probably be questionable, owing to capillarity. I would observe, also, that the 0·07 applies to graphite in general; I do not know what exactly may be the resistance of the carbon thread lately come into use.

In order to measure these changes of potential in terms of the barometric height, the whole circuit is treated at the observatory as one resistance in a Wheatstone's Bridge. Thus, in Fig. 1 let A be the distant barometer, B and C battery and galvanometer in the observatory, D—also in the observatory—a means of altering *ad lib.* the resistance in the second circuit of the bridge. The instru-

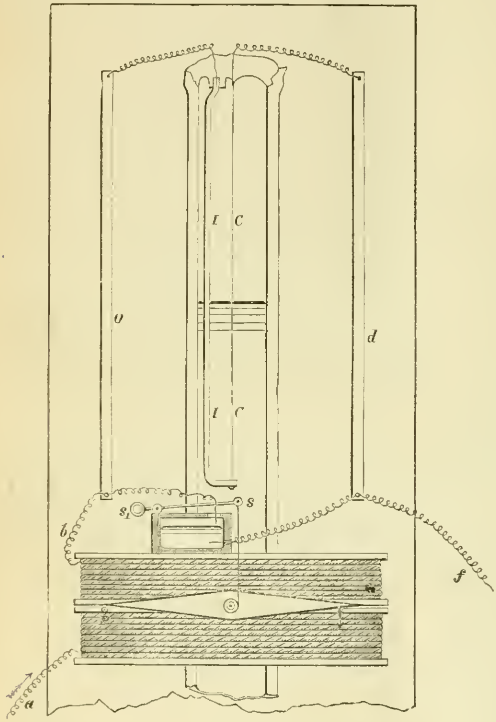

Fig. 2.

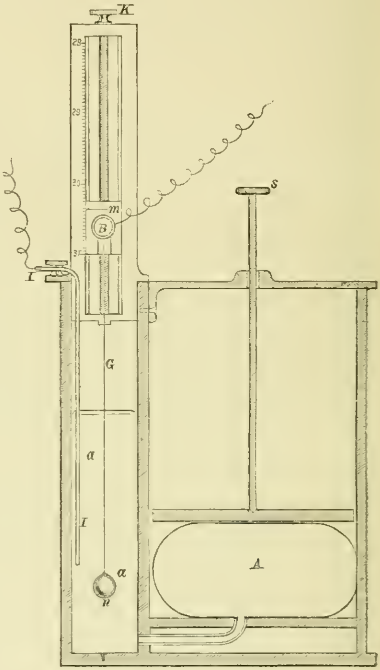

Fig. 3.

ment used at D indicates the barometric height at A when the galvanoscope is brought to zero.

Before describing the apparatus used at D, it is necessary to explain how the question of temperature is dealt with. Copper has its resistance increased by about 0·4 per cent. for each rise of 1° C. above 20° C.; and as the temperature along the four miles traversed by the wires is wholly unknown, some means must evidently be found for allowing for errors from this source. The problem is to do this without necessitating extra wires to barometer A.

It is obvious that if the barometer could be thrown out of circuit before each observation, and the resistance of the eight miles of circuit independently balanced in the bridge at D, then, restoring the barometer, a second determination made at D would yield results which might be dealt with quite independently of the resistance of the wires.

This can be effected by sending a reverse current through the circuit immediately before each observation. The apparatus shown in Fig. 2 explains this. The figure is an elevation showing the upper part of the barometer. The iron wire I and the carbon C are shown in position. The galvanometer placed immediately in front of the tube is contrived to deflect the current from the barometer when the current traverses it in one particular direction. It will be best understood, if the action of the current be considered in detail throughout the operation of reading.

We desire, in the first place, to find the resistance of the circuit independently of the barometer.

A current is sent along the wire a (Fig. 2) from the observatory. It traverses the coils, issuing by wire b, and, during the first instant of time, takes its course along the conductor o, passing through iron wire and carbon, and by d, f, back to the battery. The needle, however, is immediately deflected (in the direction shown by the arrow) pulling down the little lever $s\,s$, which, oscillating on the edge of a small vessel of mercury, and bearing a branch from the wire b, completes a circuit of low resistance with the return wire f, a branch from which communicates with the mercury in the vessel. A current is now flowing free of the carbon. It may be balanced at D (Fig. 1), and the second operation commenced. This consists in switching the current by a commutator, so that it arrives by wire f, and returns by wire a. The current on arrival tends to restore the needle to the horizontal, pressing it against the stop P. This, also (being the best position for deflection), is designed to be its position of equilibrium; the counterpoise s, being utilised to this end. The needle being horizontal, the low-resistance circuit is open, and the current must pass through the carbon to return to the battery. It is then again balanced at D, and the resistance of the carbon accurately determined.

Turning to Fig. 3 we find that the instrument used at D (Fig. 1) consists of a deep vessel of mercury $a\,a$, communicating with a flexible reservoir A, which is under the control of the screw s. A scale is mounted on the vessel carrying a marker, m, which is movable on the screw attached to knob k; to the marker a thread of carbon, similar to that in the distant barometer, is attached, it is kept vertical and rigid by a small varnished platinum weight n, beneath the surface of the mercury. The marker is of ivory, and a binding screw, B, keeps the carbon in circuit, the circuit being completed through the mercury and iron wire I.

For equalising the resistances in the bridge, when the barometer is out of circuit, the screw S is turned, and the mercury thus raised or lowered on the carbon, till the galvanoscope returns to zero. This being effected, and the barometer restored to circuit, the galvanoscope is once more brought to zero by turning the knob K. The marker M now reads the height of the distant barometer.

The scale, in Fig. 3, may not really be one of inches and fractions of inches; it may have to be divided by experimentally comparing the two carbons. Probably it would be hopeless to expect them to be exactly similar in section throughout their entire lengths.

There are many ways of rendering this method of determining the height of a barometer by resistance more sensitive. It was suggested to me, for example, to double the effect on the resistance of any movement, by replacing the iron wire in the barometer by a second carbon. With this arrangement, moreover, if we still retain but the one carbon for equalisation (Fig. 3), the range is doubled, and the chances of errors correspondingly diminished.

Other meteorological instruments may also be read by this method. J. JOLY

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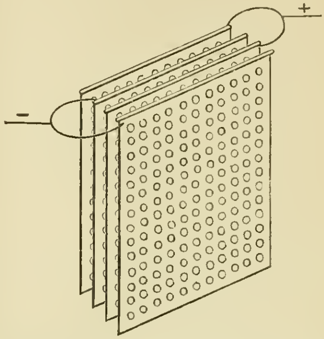
ELECTRICITY AT THE CRYSTAL PALACE

IV.—*Electrical Accumulators.*

THE new accumulator of Messrs. E. Volckmann and J. S. Sellon, exhibited at the Crystal Palace Electrical Exhibition, in connection with the Lane-Fox system of electric lighting in the Alhambra Courts, has already been announced, but its construction has hitherto been kept a secret for reasons of patent right. The storing-power of this new secondary battery may be gathered from the fact that 33 cells feed 201 Lane-Fox incandescent lamps, nominally of 20-candle power for 7 hours at a time, if the battery is fully charged to start with. The actual light of each lamp, however, is nearer 30 candles; and it is found that these lamps, which are designed to bear a 20-candle current from the generator, will stand a 30-candle current from the accumulator owing to its more uniform flow.

Each cell is stated to contain 5 horse-power of energy acting for an hour, or 1 horse-power for 5 hours, and so on. It consists of a series of metal plates of some alloy, each plate being $\frac{5}{16}''$ thick, and perforated with round $\frac{1}{2}$ inch holes, as close as they can be punched or cast. These plates are connected alternately in series like the plates of a condenser, as in the figure, and joined to two



stout terminals, which are the poles of the cell. The holes are filled with a metallic paste, the composition of which is not yet divulged, but may readily be guessed, from the fact that metallic lead is reduced on the negative plates, and peroxide of lead on the positive plates. The spaces between the plates, which are placed nearly an inch apart, are filled up with water mixed with one-tenth part of sulphuric acid, to give good conduction. The whole is contained in a wooden trough about 30 inches square and 8 inches in thickness. The weight of each cell is about 375 lbs., including 295 lbs. of the metallic composition which is the storing agent. The sparks given off on connecting several cells of the charged battery by a stout copper wire are remarkably violent, the deflagrated wire flying off in a perfect shower of red-hot sparks of copper accompanied by loud cracks. On examining the wire afterwards, it is found to be literally torn asunder in small pieces by the force of the discharge. A considerable quantity of hydrogen is evolved from the cells.

The exhibition of Lane-Fox lamps fed from this battery is without doubt the most beautiful display of incandescent lighting which has yet been made in this or any other country. This, however, is chiefly due to the designs of the ornamental lamps employed to show off the rich architecture of the Moorish courts. The arches of the courts are picked out with rows of lamps having bulb or opal glass, which give a very pleasing light, not in the least dazzling to the eye, but at the expense of 25 or 30 per cent. of the light. A crystal chandelier of the same kind of bulbs hangs in the Lion Court, and it is a moot point whether these opal globes, or globes of clouded glass are not best adapted for incandescent lamps in dwelling-rooms and studies. It is certain that the naked lights, though absolutely steady, have a dazzling effect on the eyes if looked at, which cannot but be injurious to the sight. The gems of the display are, however, three Mauresque electroliers designed by Mr. E. R. Johnson for Messrs. Verity Brothers, Regent Street. These large pagoda-like lanterns are hung in the inner courts, and the lights contained inside are only visible through the

stained glass of the sides and bottom. The power of the lamps is ingeniously graduated by simply switching on or off more cells of the battery.

Rumours of at least two other secondary batteries of great promise are in the air; but it is not yet known what these are, and they have not been exhibited in action yet before the public. They are doubtless modifications of some or other of the ordinary voltaic batteries by which their action can be conveniently reversed, and the alteration patented. For it is obvious that the old combination pure and simple cannot be patented for a new purpose. It must be changed in some way or other, though the essential action may be pretty much the same.

The well-known Faure battery, which is exhibited by La Force et la Lumière Company, in the Western Corridor, still continues to excite a good deal of debate amongst the Faurites and anti-Faurites. The construction of the battery has already been described in NATURE, vol. xxv. p. 461; but some recent experiments by a group of French *savants* have contributed some further matter to the discussion of its merits, and as their results must be considered free from bias (which is perhaps more than can be said for all that has been written on the subject in this country) we shall give them in a condensed form.

The experiments were made at the Conservatoire des Arts et Métiers, Paris, by MM. Allard, Le Blanc, Joubert, Potier, and Tresca, in continuation of experiments begun during the latter part of the Paris Electrical Exhibition. The results were communicated by the authors to the French Academy of Sciences, on March 6. The battery consisted of thirty-five cells, of the new pattern, with plates rolled up together. Each cell weighed 43·7 kilograms, including the liquid. The lead plates were covered with minium to the amount of 10 kilograms per square metre. The solution was formed of distilled water, mixed with one-tenth of its weight of pure sulphuric acid. It will be seen that the cells were in the most favourable condition for experiment.

They were charged by a Siemens' machine, of which the armature resistance was 0·27 ohms, and the resistance of the inducing magnets was 19·45 ohms. The latter were excited by the current in a derived circuit from the main current in the armature. A species of voltameter was used to regulate this exerting current, so as to keep it between 2 and 3 ampères.

The object of the experiments was to measure—

1. The mechanical work expended in charging the battery.

2. The quantity of electricity "stored" during the charge.

3. The quantity of electricity yielded up during the discharge.

4. The electrical work actually done during the discharge.

It was also necessary to know, at each instant of the experiments, the electromotive force and the resistance of the battery; and further, as the discharge should make itself through a series of Maxim incandescent lamps, to study the variation of the resistance, and the luminous power of these lamps, according to the intensity of the current.

The mechanical work was measured by a totalising dynamometer, constructed for the French Society of Agriculture by Messrs. Easton and Anderson, after the model belonging to the English Royal Society of Agriculture. The luminous intensity was measured by a Foucault photometer, such as was employed in the Exhibition experiments. As to the electric measures they were made by means of a Marcel Deprez galvanometer which measured the total current generated, and sometimes the exciting current on the magnet; a Siemens' electro-dynamometer which measured only the charging current; and a dial electrometer arranged according to a plan of M. Joubert, which gave the difference of potentials between the two poles of the battery. The indications of all the instruments were read off every quarter of an hour, sometimes at closer intervals.

The following table gives the principal results:—

TABLE I.—*Charge of the Battery*

Date.	Duration of experiments. h. m.	Speed of the dynamo.	Indicated work in kilogrametres.	Mean E.M.F. of the battery in volts.
January 4	5 30	1079	2,414,907	82·21
,, 5	7 0	1072	2,772,292	91·08
,, 6	7 30	1083	3,246,871	92·91
,, 7	2 45	1085	1,135,728	92·06
	22 45		9,569,798	
		Deduct	808,750	
			8,761,048	

(The work deducted was lost in the transmission of the indicated power to the dynamo.)

Date.	Duration of experiments. h. m.	Mean intensity of charging current in ampères.	Mean intensity of exciting current in ampères.	Quantity of electricity furnished by the battery in coulombs.
January 4	5 30	10·93	2·46	216,400
,, 5	7 0	7·97	2·81	200,800
,, 6	7 30	7·94	2·33	214 300
,, 7	2 45	6·36	2·18	63,000
	22 45			694,500

Date.	Duration of experiments. h. m.	Electric work of the charge in kilogrammetres.	Electric work of excitation in kilogrammetres.	Electric work of the ring in kilogrammetres.
January 4	5 30	1,814,600	408,400	94,400
,, 5	7 0	1,947,100	676,300	79,100
,, 6	7 30	2,028,800	596,100	76,800
,, 7	2 45	591,600	202,800	19,500
	22 45	6,382,100	1,883,600	269,800

The same determinations have been made during the discharge, observing at the same time the power of 12 Maxim lamps in a derived circuit. The light of a Carcel lamp was obtained from this experiment with an expenditure of 5·8 kilograms of electric work per second.

The following table gives the results for the discharge of the battery:—

TABLE II.—*Discharge of the Battery*

Date.	Duration of the experiment. h. m.	Mean E.M.F. of the battery in volts.	Mean resistance of the current in ampères.	Quantity of electricity in coulombs.	External electric work in kilogrammetres.
Jan. 7	7 19	61 39	16·128	424,800	2,608,000
,, 9	2 20	61 68	16·235	194,800	1,201,000
	10 39			619,600	3,809,000

The conclusion from these results is that between the quantity of electricity put into the battery (694,500 coulombs) and that got out (6,196,000 coulombs) there is a difference of only 74,900 coulombs, corresponding to a proportional loss of 10 per cent. (0·108). This refers, however, to the *quantity* of electricity, not, be it remembered, to the power stored. The electric work during the entire discharge was 3,809,000 kilograms. The mechanical work expended was 9,570,000 kilograms, but only 6,382,000 kilograms was really stored by the battery. It follows that the work recuperated or given back by the discharge of the battery is to that stored up, as 3,809,000 is to 6,382,000: that is to say, about 60 per cent. of the energy of the current was rendered up by the battery. If we compare the work recuperated with that indicated by the dynamometer, the percentage given back is still less, namely, 40 per cent.

This considerable loss of power, whilst the quantity of electricity is nearly the same in the charge and discharge,

is due to the fact that there is a marked loss of electromotive force in the battery. Thus the charging current had 91 volts, while the discharging current had only 61·5 volts. It follows, from a consideration of the theory of the battery and the formula—

$$a = \frac{I'(E' - R'I')t'}{I(E - RI)t}$$

that the efficiency must always be less than unity, but may be greater as the intensities and resistances are less. In the formula, E is the E.M.F. of the battery, R its internal resistance, I and t the intensity of the current and its duration during charge, while the same letters marked serve for the corresponding quantities during discharge. It is therefore advantageous to charge the battery with a feeble current flowing for a long time. It was observed also, that the resistance of the battery was lower during discharge than charge.

To sum up, the charge of the battery requires a total mechanical work of 1·558 horse-power during 22h. 45m., which is equivalent to a horse-power during 35h. 26m. The battery only received 66 per cent. of the total work expended, the rest being lost in overcoming passive resistances, and exciting the field magnets. Only 60 per cent. of this power stored was yielded back by the battery, and there is reason to believe that the same result will be forthcoming in all applications similar to lighting by Maxim lamps.

THE WILD SILKS OF INDIA[1]

THE laudable efforts of the Indian Government to utilise the various products of which these wild silks form a class will tend, by the immediate production of wealth, and yet more by the spirit of intercommunication and enterprise thus created, to overcome the great difficulty of poverty and still greater difficulty of isolation, which so tasked its efforts in the last famine. And this work is the more desirable because, as the last census shows, the peaceful, firm rule of the British in India has removed that natural check to population which was found of old in the mutual internecine wars of its peoples; and numbers have increased to such an extent that the failure of a crop over any wide district is invariably followed now by a famine.

The principal varieties of wild silks found in India are the Tusser, or Tasar, the Eria, and the Muga, or Moonga, silks, besides several others, at present of little commercial importance.

Silk differs from all other materials used in textile fabrics in the nature of the thread as originally produced. Hemp, flax, cotton, wool, and many other threads are produced by the twisting tightly together of the short but very fine fibres of the raw material, the untwisting of which reduces the thread again to short loose fragments. The long fibre of the best Sea-Island cotton does not much exceed 1½ inches in length. Silk, on the other hand, is spun by the silkworm (except that it is not a worm, and does not spin it!) in one long thread: three-quarters of a mile is quoted by Mr. Wardle as the length of the thread of a Tusser worm. There is no "spinning" in the process at all, but two fine threads come from the spinnarets of the grub as from the spinnarets of a spider in such a glutinous semi-liquid condition that they coalesce into one thread, which, in the best kind of silkworms, can be wound without a break from the outside of the suspended cocoon to where the grub left off spinning and turned into a chrysalis. The silk-reeler does not, even in the coarse Tusser variety, reel off a cocoon of this singly, but from four to six together, whose gummy surfaces make them combine into a single thread still fine.

[1] "Handbook of the Collection Illustrative of the Wild Silks of India in the Indian Section of the South Kensington Museum," by Thomas Wardle. (Eyre and Spottiswoode, 1881.)

The Eria cocoon is not found practically so available for this treatment, but, in addition to the beautiful continuous thread of the Bombyx or Tusser silkworm, the waste part of their cocoons can be treated like the vegetable fibres (cotton, &c.) of which we spoke with equally good results as a textile material, and with nearly all the beauty of the perfect silk thread. For this purpose the whole of the cocoon of the Eria is specially available, and, instead of being carefully reeled off, it is cut up or torn into shreds by the carding machine, and then treated as a long staple cotton. This is known as spun silk, or by the more recent name of Schappe. If, however, the surface of such a thread is examined, even with small magnifying power, it will show the loose ends of the fibres sticking out in every direction; and although they are individually too fine to attract the attention of the naked eye, in combination they are quite patent to the finger and to the ear, a soft deadness resulting instead of the sharp whistle of the natural silk, on which are no fibres except the ends left by careless throwsters.

Another inferiority of spun silk, though not a great one in the ever-changing fashionable world of England, is that it has not the durability which distinguishes the continuous silk thread. Yet in India garments made from the former are handed down from mother to daughter!

The Tusser or Tusseh larva, whose coarse, strong thread is available for thrown silk, is a monster compared with the larva of the *Bombyx mori*, or common silk-worm, It measures 7 inches in length and 1 inch in diameter; the wings of the moth—a very handsome one—are 7 inches across, and the thread also is three times as coarse, and three times as strong as that of the China silkworm. Here, however, comes an objection to it in the eye of the manufacturer. While the thread of the Bombyx is almost round, the extra coarseness of the Tusser thread all consists in its extra width: it is, in fact, three times as broad as it is thick. Like any thread of this shape compared with a round one, it has a great tendency to split, and consequently become rough in working. Another difficulty to both reelers and dyers is caused by the substantial way in which the Tusser grub forms its cocoons. Major Coussmaker observes that—

"As the chrysalis remains in the cocoon as long as eight months, exposed to the hottest sun and occasional thunderstorms, the cocoon had need to be made a hard impenetrable material; so indestructible is it, that Bheels and other tribes which live in the jungles, use the cocoon as an extinguisher to the bamboo tube in which they keep the 'falita' or cotton tinder used by them for lighting their tobacco and the slow matches of their matchlocks. The cocoon is also cut into a long spiral band, and used for binding the barrel of matchlocks to the stocks, being, as the natives say, unaffected either by fire or water. . . . . After the caterpillar has spun a layer of silk thick enough to conceal itself, it discharges some kind of gum or cement, thick like plaster of Paris, and with its muscular action it causes this secretion to thoroughly permeate the whole cocoon and solidify the wall. In this manner it goes on spinning layer after layer of loops, and cementing them altogether until the whole of its silk is exhausted, and the wall of the cocoon becomes so hard that it requires a sharp penknife to cut through it" (pp. 18, 19).

Again, in a later report (February 21, 1880), Major Coussmaker writes:—

"One of the most interesting, and I think important, facts that I have this year been able to prove, is with regard to the composition of the cement with which the caterpillar hardens its cocoon. Former analyses of this agent made for me, in England by Dr. Taylor, and in Bombay by Dr. Lyon, had shown that it contained the acid urate of ammonia, that it was in fact excrementitious; and this year, by opening the cocoons at various intervals, I was able to convince myself of the fact that when the caterpillar has left off feeding and begins to spin, it voids

the food remaining in the alimentary canal, first of all in a more or less solid form and of a dark colour, but after it has become fully enveloped in the cocoon the excrement comes away as a light-coloured liquid, the hue and consistency of which depend upon the amount of vegetable matter not previously evacuated and the amount of lime, carbon, and ammonia present. The respective proportions of these ingredients vary, I presume, with the food upon which the caterpillar has fed, and with the state of the atmosphere at the time of spinning; also the longer they remain coating the fibre the harsher and more discoloured it will be. It is therefore very necessary, I think, to remove this cement at a very early date; and this chemistry has shown the manufacturers how to do. Judicious feeding too may alter its nature. Before long, fresh cocoons will be at an early stage thoroughly cleansed from all discolouring matter, and Tasar silk will be available for manufacturing purposes as colourless as it is when first put forth by the caterpillar" (p. 21).

At any rate here is a fine field for both economic and philosophical results for both the chemist and the naturalist.

There are two crops of Tusser silk in the year, *i.e.* two generations of grubs pass from the egg to the imago, whereas the Bombyx of commerce so passes only once. The moth is considered a sacred insect, and it is interesting to read of the long series of ascetic ordinances connected with the attendance upon it, the failure to observe which will bring down the anger of the gods and destruction upon the cultivators. Yet the grubs are said to flourish better out-of-doors than under the roof and care of men, and are found feeding upon seventeen different species of trees growing wild over various parts of Hindostan. It is much more practicable and hopeful to engage the unenterprising natives in its collection under these conditions than if the elaborate art with which the Chinese cultivate the Bombyx were required.

The silk of the Eria and Moonga or Muga cocoons is softer and of a clearer colour than the Tusser silk, but lacks the strength of that very coarse variety. It dyes well, but is difficult to wind. In all respects therefore it is easier to work it up into spun silk.

The favourite food of the Eria is the *Palma Christi* or castor oil plant, *Ricinis communis*. So productive is this worm that it sometimes gives twelve broods, *i.e.* generations, in a year.

The Muga worm breeds five times; the colour of the silk varies with the food, some of it retaining its drabby colour till the last. The moths of all these genera are large and handsome. The magnificent *Attacus atlas* moth, called in France Le Géant des Papillons, measures upwards of ten inches in expanse of wing. It is a common idea that moths *eat* their way out of their cocoons, and that all permitted to do so spoil their silk; but even in the case of the solid cocoon of the Tusser moth it is observed that "after eight or nine months in the pupa state a moist spot is observed at one end of the cocoon. The moth is now about to emerge both from its pupa shell and from the cocoon. It secretes an acid fluid which softens the cement of the cocoon, and enables it to separate the fibres sufficiently to allow of its creeping out" (p. 19). Capt. Brooke also says that "in Seonee the pierced cocoons are wound, and that no koshtee rejects a cocoon simply because the moth has eaten its way through it. . . . It does not eat its way out but separates the fibres with its legs and wing-spine, and so creeps out. It has neither teeth nor mouth proper" (p. 26). More remarkable still is the provision made by the larva of this *Attacus atlas*, "the upper extremity of whose cocoon forms a natural orifice for the exit of the moth, made by the conveyance of a great number of silk fibres which are left ungummed, and are thus soft and flossy; thus the exit of the imago leaves no disturbance behind" (p. 63).

The most interesting question, of course, is, how far care and industry can improve this imperfect natural wealth. The strongest proof of the value of such education is to be found in the fact that the beautiful Italian and French silks, whose fineness and regularity insure for them a price 50 per cent. higher than the best China silks, are the lineal descendants of the eggs brought from China in the reign of Justinian. The destruction caused among them by the dreadful disease, pebrine, has necessitated the import into Europe of Japanese eggs, the drabby colour of the silk of which marred all the efforts of the dyer to obtain clear delicate tints, especially in different shades of white; but careful attention and artificial selection are bringing them near to equality with the pure European silk; and Major Coussmaker in Pooneh has succeeded in obtaining perfectly white Tusser silk by causing the caterpillar to void all its excrement before spinning.

The special fitness of Tusser silk for the dark dull colours now fashionable is most optimistically expressed by Mr. Wardle in the phrase that "Tusser silk properly dyed inherently takes shades of *artistic merit*." Is dirt then beauty? and purity and brilliancy essentially vulgar?

There can be little doubt that European skill and machinery would more than balance the cheapness of Indian labour, which could be trusted to produce only the commonest qualities of thrown silk. It is also far safer and less likely to end in failure or discouragement to make spun silk the object of Indian produce than to attempt to rival the beautiful productions of Italy and China.

One cannot help noticing with satisfaction in this concise history the working together for good of such widely separated parties as, in India, the high Government official, the investigating naturalist, the active military officer in charge of a district; then the organising British manufacturer, who brings into willing co-operation the Italian throwster, the Leek dyer, the Halifax weaver, the London artist, not to mention the taste and skill of the lady-bountiful of her neighbourhood. W. ODELL

NOTES

On Tuesday evening, April 11, the public thoroughfare stretching between Hatton Garden and the Old Bailey was lighted for the first time by the electric light. The novelty of the installation was the fact that the incandescent system had been adopted in preference to the arc system. Mr. E. H. Johnson, the agent of the Edison Electric Light Company, has in fact made a public demonstration of the Edison system by lighting up a district of London in the same way as by gas. In addition to the street lights, the different premises lining the street are also lighted; for example, the City Temple Church, Messrs. Negretti and Zambra's, Messrs. Spiers and Pond's. In all there are 936 incandescent lamps, and these are fed by one of the large dynamos stationed at No. 57, Holborn, the distributing centre of the company. These large generators are made upon the same plan as the smaller ones recently described by us, and are driven by Porter engines. They yield a current of 1025 ampères. The resistance of each lamp white-hot is 140 ohms, and as this is much greater than the hot resistance of other incandescent lamps, the resistance of a long circuit is not so relatively high as in other systems, and hence there is less need of large leads. The cost of copper for conductors is an important item in electric lighting, but should copper conductors become too expensive to use, Mr. Edison intends to employ iron, say old iron rails. Mr. E. H. Johnson states that the company intend to manufacture and supply electricity for all kinds of purposes, and judging from experience gathered in New York, where a district is lighted by this system, the profits from the sale of electricity for power purposes alone will pay the company's dividends, so that they can afford to give the light for nothing. This remark is a rejoinder to those

who argue that the gas companies will successfully compete with the electric light, because the profits from their waste products will pay their dividends. The Holborn street lamps each contain two of Edison's bulbs suspended from a cross bar running through the top of the lantern. The light is of a golden tinge like gas, but much purer, brighter, and steadier. The lamps were switched on and off with the greatest ease, and altogether the experiment was a complete success.

THE Commission of the French Academy of Sciences for the Transit of Venus expeditions have completed their work. All the astronomers selected are practising daily at the observatory, taking readings with the artificial transit apparatus, invented by M. Wolf on the occasion of the last transit. In spite of some objections, which have been disregarded, three kinds of observations will be taken: (1) by direct contact; (2) by refracting prisms and micrometrical distances; (3) by photography. The stations are the following: French Antilles (Guadeloupe or Martinique), directed by M. Tisserand; Spanish Antilles (Cuba), M. d'Abadie; Florida (United States), Col. Perrier; Coast of Mexico, M. Bouquet de la Grye; Patagonia (on the Rio Negro), M Perrotin, director of the Nice Observatory; (M. Bischoffsheim will be at the expense of the partial fitting out of this expedition); Santa Cruz, Capt. Fleuriais. It is to be remarked that very few of the heads of the missions sent out in 1874 have been appointed again by the French Institute. Four of these eight stations are located in the northern hemisphere, and four in the southern. At all of them will be observed the entrance and the exit.

THE use of Jablochkoff lights in the Avenue de l'Opera has been discontinued, the Municipal Council of Paris having refused to grant a concession of ten years, which was asked for by the Company. It is said that other electric light companies will make proposals for the illumination of that fashionable part of Paris. In the meantime M. Cances, the inventor of a new regulator, is illuminating experimentally the rue de Crassant, a long and narrow lane of Central Paris, where newsagents have congregated for the last half century.

ON March 20 last, William Edward Gaine, C.E., the inventor of parchment paper, died at the residence of his son, at Blackburn, at the age of sixty-five.

THE usual Congress of Astronomers and Meteorologists will take place this week in Paris, as well as the Congress of the Sociétés Savantes, the annual meeting of the Société de Physique, and the Association Scientifique de France. But the Congress of Instituteurs and Institutrices has been postponed for a future period. M. Ferry will deliver as usual the official speech as Minister of Public Instruction, on Saturday, on the occasion of the distribution of prizes to the delegates of learned societies.

MM. MIGNAN AND RANARD have constructed an integrating hygrometer for precipitating the vapour of the atmosphere, and analysing the products if required. It is composed of an iron tube filled with liquor ammoniæ; by gently opening a taper the ammonia is absorbed by water and the hygrometer is covered with moisture which is collected in a cup arranged for the purpose. During the recent dry weather the amount of precipitation was 3 grammes of water in twenty minutes. The weight of liquor ammoniæ was 34 grammes. A peculiarity is that a number of floating particles are precipitated with the humidity of the air. It has been suggested by M. W. de Fonvielle that the hygrometer might be used for analysing the matter of clouds where the precipitation of a few grammes will be a question of a very few minutes.

EXPERIMENTING with electro-magnets on various minerals, Prof. Doelter has made the interesting observation that the absolute amount of iron present does not determine the degree to which the minerals are attracted, for sulphides and sulphates containing much iron are very little attracted, while the attraction of oxides, carbonates, and silicates is strong. This varying amount of attraction (it is pointed out) may be of service in mechanical separation of natural mixtures of ores, purifying ores, isolation of rock matter, and approximate estimation of quantitative mineralogical composition.

THE project started by Admiral Mouchez of building a captive balloon for observing the conditions of the air at several hundred metres from the earth will be abandoned; but a captive balloon will be established at Montsouris Meteorological Observatory.

THE deaths are announced of Prince Wladislaus Lubomirski, an eminent conchologist, who recently died at Warsaw, aged fifty-eight; and of Prof. Vincenz Kletzinsky, Professor of Chemistry at the Wieden Communal School, who died at Vienna on March 18 last, aged fifty-six.

THE Ethnographical Congress which was to meet this week at Geneva has been indefinitely postponed. The number of participators who intended to be present from England, Germany, Austria, and Italy was not considered sufficient by the Committee.

MOUNT ETNA has again been in an active condition. An eruption and a rain of ashes (rampilli) has quite recently alarmed the neighbouring inhabitants.

THE first number is published of Dr. M. C. Cooke's "British Freshwater Algæ" (exclusive of Desmidieæ and Diatomaceæ). As no systematic work on the subject has been published since Hassall's in 1845, a good account of British Freshwater Algæ is much wanted. In the present number, which includes the Palmellaceæ only, Dr. Cooke has perhaps already reached the most difficult part of his work, the history of development of some of these lower organisms being still very obscure. We could have wished to see, at the outset, a greater effort to give the student something approaching a natural classification of Algæ, instead of the very rough and artificial one which Dr. Cooke has adopted. The exclusion of the desmids and diatoms is wise, these forming a separate literature of their own.

PROF. E. MORREN issues the ninth annual edition of the "Correspondance Botanique" (Liste des Jardins, des Chaires, des Musées, des Révues, et des Sociétés de Botanique du Monde), well posted up to the close of the year 1881.

IN addition to the above catalogue, the *Bulletin de la fédération des Sociétés d'Horticulture de Belgique* (1881), published under the authority of the Belgian Government, contains the official report of the National Exhibition of Horticulture and Pomology, held at Brussels in 1880, in honour of the fiftieth anniversary of the independence of Belgium; much other horticultural information, and a paper on the Bromeliaceæ of Brazil.

SINCE March 1 a new Spanish periodical, *Revista Germanica de Literatura, Artes y Ciencias*, is published at Leipzig twice a month. Its editors are Señores S. Gimenez and J. O. Monasterio; Herr L. Seidel is the publisher. The object of the serial is to facilitate intellectual intercourse between Germany and the Spanish races.

AT the last meeting of the American Association a lecture was delivered by Capt. C. E. Dutton, of the United States Geological Survey, upon the "Excavation of the Grand Cañon of the Colorado River." The lecture was illustrated by a large number of lantern views. A picture of the chasm, at a point about the middle of its length, was exhibited as a type, showing that it consists of an inner and an outer gorge, or an upper and a lower chasm. The outer one is about five miles in width, with palisades on either side, very nearly 2000 feet high, facing each other across a comparatively smooth plain or valley floor.

Within this floor is sunken the great inner gorge, 3000 feet deep, with nearly vertical walls. The width of the inner gorge is about the same as the depth, or 3000 to 3500 feet. The strata exposed in this section are 4500 feet of Carboniferous (the entire local series), and 500 or 600 feet of Lower Silurian or Primordial. The speaker then indicated the salient features of the topography and stratigraphy of the country in the vicinity of the chasm. It is for the most part a desert plain, surfaced by the summit beds of the Carboniferous, with low mounds or flats consisting of remnants of the Permian, and occasionally a small remnant of the Lower Trias. Forty miles north of the chasm is found the main Permian mass lying as a higher bench or terrace terminated southwardly by a cliff. Proceeding northward, the Trias, the Jurassic, the Cretaceous, and the Lower Eocene systems are successively encountered, each at intervals of five to ten miles. Each of these formations is likewise terminated southwardly by a great cliff, and the whole series, from the Permian to the Eocene inclusive, constitute a stairway leading up to the high plateaux of Utah. Capt. Dutton stated that conclusive evidence has been found that these terraced formations, thus abruptly terminated, once extended southward across the Grand Cañon and far into Central Arizona, but have been denuded down to the summit of the Carboniferous. The total thickness of beds removed was a little over 10,000 feet, and the eroded area was from 13,000 to 15,000 square miles. This area is called by him the Grand Cañon district. The erosion began about the middle of Eocene time, and has continued uninterruptedly to the present. The cutting of the Grand Cañon is merely the closing episode of a much greater work. The excavation of the present cañon is a comparatively recent geological event, and Capt. Dutton is of the opinion that its origin does not antedate the Pliocene period. He then explained some of the more important considerations and conditions upon which the cutting of cañons depends, and showed the natural mechanical process of creating and maintaining the singularly beautiful and architectural profiles of the cliffs, and how their wonderfully constant outlines are preserved. He then entertained his audience by a graphic and enthusiastic description of the phenomenal scenery revealed in the wider and deeper portions of the chasm.

THE geology of Spain being yet very imperfectly known, we are glad to find in a recent number of the *Boletin* of the Geographical Society of Madrid the continuation of Don Juan Vilanova's paper on the geological survey of the province of Valencia, being a description of the Tertiary formation of the province. This formation consists of conglomerates and clays covered with marls, sandstones, grits, and gypsum, with beds of lignite and peat. The surface is undulated, forming low hills with gentle slopes, but intersected with deep ravines, or barrancos, or terrace-like, with deep ravines, along which streams flow in cascades during the rainy season. Wide lacustrian basins at Bicorp, which were considered by Verneuil as Cretaceous, belong also to this formation.

THE Jubilee Meeting of the British Medical Association will be held at Worcester, on August 8–11. The president-elect is Dr. William Strange, senior physician to the General Infirmary, Worcester.

PROF. HAECKEL is giving some account of his recent visit to Ceylon and India in the *Deutsche Rundschau*.

WE read in the "Diario de Manila" that a German ethnologist, Dr. Schadenberg, of Breslau, has now resided for some time amid the savage tribes in Sibotam, at the foot of the Volcano of Apo, for the purpose of studying the ethnography of the tribes of Atas, Bagobos, Manobos, Mandayas, Tagacaolos, Vilanes, Samales, Sanguiles, Moros, and Guiangas. All these races differ materially in language, religious customs, attire, and habits, so that Dr. Schadenberg has certainly selected a rich field of study.

IN a *brochure* published by Messrs. Sampson Low and Co., Col. Burnaby has given an interesting narrative of his recent balloon trip across the Channel.

THE additions to the Zoological Society's Gardens during the past week include a Black-eared Marmoset (*Hapale penicillata*) from South-East Brazil, presented by Mrs. Davidson; a Ring-tailed Lemur (*Lemur catta* ♂) from Madagascar, presented by Dr. J. Lea, M.R.C.S.; two Grey-backed White-eyes (*Zosterops dorsalis*) from Australia, presented by Mr. J. Abrahams; a Jardine's Parrot (*Pœocephalus gulielmi*) from West Africa, presented by Capt. H. Hope Keighley, 2nd W.I. Regt.; three Zebra Waxbills (*Estrelda subflava*), a Shining Weaver Bird (*Hypochera nitens*) from Africa, two Amaduvade Finches (*Estrelda amandava*) from India, a Crimson-eared Waxbill (*Estrelda phœnicotis*) from West Africa, presented by Mrs. Beauclerk; a Common Buzzard (*Buteo vulgaris*), British, presented by Mr. J. C. S. Rocke; a Common Partridge (*Perdix cinerea* ♂), British, presented by Mr. H. T. Bowes; a Long-tailed Copsychus (*Copsychus saularis*) from India, deposited; a Mantchurian Crossoptilon (*Crossoptilon mantchuricum* ♂) from North China, two Japanese Pheasants (*Phasianus versicolor* ♂ ♀) from Japan, an Amherst Pheasant (*Thaumalea amherstiæ* ♀), a Gold Pheasant (*Thaumalea picta* ♀) from China, a Lineated Pheasant (*Euplocamus lineatus* ♂) from Tenasserim, two Black-backed Kaleeges (*Euplocamus melanotus* ♂ ♀) from Sikkim, two White-crested Kaleeges (*Euplocamus albo-cristatus* ♂ ♀) from North-West Himalayas, two Hasting's Horned Tragopans (*Ceriornis hastingii* ♂ ♀) from North India, purchased; a Rifle Bird (*Ptilorhis paradisea* ♂) from Australia, received on approval; a Sambur Deer (*Cervus aristoteles* ♀), a Gaimard's Rat Kangaroo (*Hypsiprymnus gaimardi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

A SYSTEMATIC SEARCH FOR COMETS.—The necessity of a more rigorous and systematic examination of the heavens with the view to the early discovery of telescopic comets has been somewhat forcibly exemplified of late years, and it is satisfactory to learn that American observers are taking the initiative vigorously in this direction. A partial arrangement for regular sweeping has been made, and is detailed in a circular issued from the office of the *Science Observer*, in which also further cooperation is invited, and it is to be hoped that amateurs here with the necessary instruments, and time at command, will actively second the efforts that are being made in the United States, to further our knowledge of these, as yet, in a cosmical sense at least, problematical bodies. Mr. W. F. Denning, of Bristol, after proving his extraordinary patience and perseverance in the observation of meteors, and who has done excellent work in that class of observation, has for some months instituted a search for comets in such quarters of the sky as his position best commanded, and has made, as we know, a most notable beginning by the detection of the comet of short period, which astronomers will recognise in future as "Denning's comet." He has kindly afforded us an opportunity of perusing a letter addressed to him by Mr. J. Ritchie, jun., of Boston, U.S., from which we may be pardoned for making the following extract:—"We wish it understood that although from the circumstances of the organisation, the majority of observers are here in this country, still we do not wish to make anything exclusive or national about it, and are simply after the most scientific ways of doing certain things, and are ready to receive that advice which the experience of others renders them competent to give." Mr. Denning has found a coadjutor to divide with him the examination of the eastern sky in the morning hours, and there should be little difficulty in arranging for other amateurs here to take part in an evening search. Two or more observers in the other hemisphere will be needed to complete the regular scrutiny of the whole sky, and we do not anticipate that the scheme will be rendered imperfect for want of them.

It would be an easy matter to cite a number of cases where the earlier detection of comets would have materially aided our knowledge of their motions in space, and probably of their gradual development in approaching the sun. We may refer to

two cases of recent occurrence. The fifth comet of 1877 was detected by Tempel on October 2, when its south declination was already 10°, and its motion towards the south did not permit of its being followed after October 14, when the last observations were made at Leipsic and Milan. On the orbit being calculated, it was found that the comet had passed the perihelion as early as the end of June, and, further, that it had escaped observation before perihelion, when in a much more favourable position than at the time of its discovery by Tempel. Thus, on April 5, as the moon was drawing away from the evening sky, it was in R.A. 161°, Decl. +57°, consequently a circumpolar object in these latitudes, its distance from the sun was 1·69, and from the earth 1·05, and the intensity of light, expressed in the usual manner, was 0·32. At its actual discovery, on October 2, the distance from the sun was 1·86, and from the earth 0·88, consequently the intensity of light was 0·36, or virtually the same as on April 5. But the orbital arc available for the final calculation of the elements was less than 4½°, whereas if the comet had been detected in its more favourable position towards the end of the first week in April, there would have been available for this purpose an orbital arc of upwards of 160°.

As a second case in point, we may mention the circumstances attending the discovery of the comet by Mr. Denning last October, and its previous track. Mr. Denning found it on October 3, the perihelion passage having taken place on September 13, so that it was already at a considerable angular distance from perihelion at the first accurate observation. But prior to arriving at its least distance it had made the following tour of the southern heavens. In the column headed "Intensity of Light," the brightness at discovery on October 3 is taken as unity.

12h. G.M.T.	R.A.	Decl.	Distance from Earth.	Intensity of Light.
		°		
June 26	296·1	−33·8	0·481	0·8
July 25	280·3	66·9	0·159	11·9
30	228·5	80·5	0·128	20·4
Aug. 2	158·9	74·9	0·118	25·6
4	143·2	65·6	0·116	27·6
6	136·0	55·6	0·119	27·9
8	131·8	−45·8	0·125	26·5
Sept. 13	129·2	+11·1	0·503	2·9

With anything approaching to a regular examination of the southern sky such an object could not have escaped notice.

CHEMICAL NOTES

WHETHER the atomic weight of uranium is represented by the number 120 or 240, is still a disputed question. Experiments recently conducted by Herr Zimmermann (*Berichte*) are strongly in favour of the latter number. Herr Zimmermann has determined the densities of the vapours of uranium tetrabromide and tetrachloride, by Victor Meyer's method, at the temperature of a Perrot's furnace; his results are as follows:—

	Sp. gr. of vapour.	Calculated. U=120.	Calculated. U=240.
Uranium tetrabromide	19·46 (mean of 6)	9·68	19·36
Uranium tetrachloride	13·33 (mean of 4)	6·60	13·21

SEVERAL important papers on general considerations regarding processes of chemical change, by MM. Potilitzin, Beketow, and Kajander, have appeared in the *Journal* of the Russian Chemical Society (good abstracts in *Berliner Berichte*, xiv. 2044–2058). As a deduction from experimental results, M. Potilitzin concludes that in every reaction, whether in presence or absence of water, a division of the elements of the reacting bodies occurs, and this is conditioned by the atomic weights of the elements, and the mass of the reacting substances. Berthelot's principle of maximum work is only applicable when but a single product is formed in a reaction, and when the energy, liberated in the reaction, all appears as heat. But in actually-occurring processes of chemical change there is a conversion of potential into kinetic energy, and subsequent employment of this kinetic energy in the work of fusion, evaporation, affinity, &c. Sometimes a portion of this energy may be used in the formation of compounds wherein heat is absorbed. This change of potential into kinetic energy is counterbalanced by the conversion of energy of motion into heat: a condition of equilibrium for the entire chemical system is thus attained, conditioned chiefly by the atomic weights of the reacting elements, the masses of the chemical substances in the system, and the relative amounts of potential and kinetic energy. The heat evolved in a chemical change measures the initial velocity of that change; but the final result of the change is dependent on the attainment of a general equilibrium, the conditions of which have been stated. Any change in one or more of these conditions causes a change in the direction of the chemical reaction.

IN the paper of M. Kajander the action of acids on plates of magnesium is considered: it is shown that the velocity of the action is inversely proportional to the internal friction of the liquid: raising the temperature of the liquid acts by diminishing the internal friction.

PROF. MENSCHUTKIN continues to publish, in the *Journal* of the Russian Chemical and Physical Society his researches on the influence of isomerism on the formation of compound ethers, and deals with the etherification of polybasic acids. The researches are rendered difficult by the circumstance that we know but few polybasic acids, the structure of which is well determined. Altogether the etherification of polybasic acids is very like the etherification of monobasic acids; the limits of etherification are always high, if a primary alcohol is taken for the formation of the ether; the rate of etherification varies with the isomerism of the acid, and the variations of the rate are as in monobasic acids. This likeness is the more remarkable, as the reactions are far more complicated in this case than in the preceding one.

PROF. MENSCHUTKIN also discusses the influence of the molecular weight of homologues on the course followed by incomplete and reversed reactions. He has succeeded in establishing that the law of homology, extends as well to the chemical as to the physical properties of homologues, and as well to their complete reactions, as to the incomplete ones.

THE phenomenon noticed by Mills, and called by him "chemical repulsion"—referred to some time ago in these "Notes"—has been recently studied by Herr Lecher (*Wien. Akad. Ber.*), who thinks that there is no need for the new hypothesis of chemical action at a distance introduced by Mills. A few drops of barium chloride solution are placed on the surface of a glass plate, a second plate containing two circular holes is pressed on the first, and a drop of sulphuric acid is introduced at each hole: the formation of barium sulphate proceeds in circles which gradually extend their circumference, but cease to do so before they come into contact. The author's explanation, which is based on several experiments, assumes that the barium chloride molecules originally move equally in all directions through the liquid; the presence of sulphuric acid, however, fixes many of these molecules and prevents their moving out of the sphere of action of the acid: the space between the advancing circles of barium sulphate thus becomes gradually poorer in barium chloride, until finally the whole of this salt is removed: there is a space of no action, because the compounds which react are absent.

HERR SCHULZE (*Journ. für pract. Chem.*) describes an interesting case of so-called "catalytic action." Sulphuryl chloride (SO_2Cl_2) is not formed by the action of chlorine on gaseous or liquid sulphur dioxide, but if these gases be passed over camphor, large quantities of sulphuryl chloride are produced; five grams of camphor sufficed to induce the formation of 470 grams of sulphuryl chloride. Acetic or formic acid likewise induces the combination of chlorine and sulphur dioxide, but these compounds are themselves more or less attacked, whilst camphor remains unchanged at the close of the reaction. Acetic and formic acids dissolve considerable quantities of sulphur dioxide, but other good solvents of this compound, *e.g.* acetone, fail to induce the formation of sulphuryl chloride.

MALLET (*Amer. Chem. Journ.*) finds the number 1·759 as representing the sp. gr. of hydrofluoric acid gas at 25°, hence molecular weight = 39·32. If this determination is confirmed, the formula of the compound in question must be written H_2F_2, and not, as at present, HF. But if Mallet's formula is correct, the atom of fluorine must be divalent; it has hitherto been regarded as markedly monovalent.

M. L. DE BOISBAUDRAN (*Compt. rend.*) has prepared gallic chloride, Ga_2Cl_6. The specific gravity of the vapour of this chloride, at 273°, was found to be 11·9, which confirms the formula Ga_2Cl_6.

AN iron wire embedded in lampblack and heated to redness in the reducing flame of the blowpipe loses weight; a portion of the iron, according to Colson, diffuses into the carbon. This chemist states that solids diffuse into each other when a chemical

action can take place between the solids in contact (*Compt. rend.* xciii. 1074).

IN the *Berichte* (xv. 109) Brauner describes some new compounds of the cerium metals, especially *Cerium tetrafluoride*, CeF_4, and didymium pentoxide, Di_2O_5; he also gives data whence he deduces the value 146·5 for the atomic weight of didymium. Brauner likewise discusses the grouping of these metals in accordance with the "periodic law," and shows that didymium may fairly be placed as the eighth member of group V., the members of which group form pentoxides, M_2O_5 (see also *Chem. Soc. Journal*, Trans. 1882, p. 68).

VARIOUS new salts analogous to the ferrocyanides and ferricyanides are described by Descamps (*Ann. Chim. Phys.* [5] xxiv. 178), chiefly *mangano-* and *mangani-cyanides*, *cobalto-cyanides*, and *chromo-cyanides*.

FROM experiments on the action of sulphur dioxide on nitric oxide, Lunge concludes that, when water is present, sulphur dioxide partially reduces the higher oxides of nitrogen to nitrous oxide, even in presence of free oxygen (*Berichte*, xiv. 2196). These results of Lunge's have a direct bearing on the changes which proceed in the chambers of the sulphuric acid manufacturer.

THE synthetical production of urea, by passing air charged with ammonia and benzene over hot spirals of platinum wire, is described by E. F. Herroun in *Chem. Soc. Journ.* Heated spongy platinum, or platinised asbestos, caused a large production of ammonium carbonate with little urea; platinised charcoal caused the production of much urea, but the action proceeded more slowly than when spirals of platinum wire were employed.

FROM results of series of measurements, the following general statement regarding fractional distillation is made by F. D. Brown (*Chem. Soc. Journ.*). "In distillations with a still-head maintained at a constant temperature, the composition of the distillate is constant, and is identical with that of the vapour evolved by a mixture whose boiling-point equals the temperature of the still-head." Brown thinks that the reciprocity between a liquid mixture and the gaseous mixture evolved by it on ebullition has been too much neglected in reasonings about fractional distillation.

THE explosion of fulminate of mercury has been studied by Berthelot and Vieille (*Ann. Chim. Phys.*). The chemical change which occurs when this salt is exploded is a simple one, thus: $C_2HgN_2O_2 = 2CO + N_2 + Hg$; the heat produced, at constant pressure, per gram-molecule, is sufficient to raise the temperature of the products of explosion (supposing these already gaseous) to about 4200°. The local action exerted when the fulminate is exploded in a closed vessel is more violent than with other explosives, but the total pressure is only about three-fourths of that produced by dynamite or nitro-glycerine. The instantaneous nature of the explosion of fulminate, the almost complete absence of dissociation of the products, and the high specific gravity of the material, conspire to render the explosion of this substance very effective.

ACCORDING to M. Amagat (*Compt. rend.*) pure dry oxygen exerts no action on mercury even under pressure: this is opposed to the results obtained by Regnault.

FURTHER observations bearing on the relations existing between molecular structure and the absorption spectra of carbon compounds are described by Hartley (*Chem. Soc. Journ.*, Trans., p. 45), who concludes that "the simple union of carbon to nitrogen does not cause selective absorption of the ultra-violet rays." This conclusion is aplied to a discussion of the structural formulæ of several compounds, more especially of *cyanuric acid*, the molecule of which appears to possess "a nucleus with a compactness of structure intermediate between that of benzene hexchloride and that of benzene."

EXPERIMENTS by Remsen and Hall (*Amer. Chem. Journ.* ii. 50) on the oxidation of *sulphamine-para-toluic acid* confirm the general statement that when, in a derivative of an aromatic hydrocarbon, one of the substituting groups is electronegative, this negative group exerts a *protective influence* on the other group during oxidation.

VARIOUS papers on the cinchona alkaloids have recently been published: two new alkaloids are described, one by Arnaud, under the name of *cinchonamine* (*Compt. rend.* xciii. 593), the other—*homoquinine*—by Howard and Hodgkin (*Chem. Soc. Journ.*, Trans., 1882, p. 66). Both alkaloids are found in bark from Santander, Columbia, described by Flückiger as *China cuprea*. The structural formulæ of *quinoline*, *quinic*, and *quinuric acids*, are discussed at length by Skraup (*Monatshefte für Chemie*, ii. 587). Various sulphuric derivatives of cinchonine are described by Weidel (same journal, p. 565), and papers of importance, although too technical for detailed notice here, on cinchonine and the so-called homocinchonine, by Koenigs, Hesse, and Claus, appear in the *Berichte* (xiv. 1852, 1888, 1890, and 1921).

REINCKE states (*Berichte*, xiv. 2144) that he has obtained aldehydic substances from the juices of chlorophyll containing plants. The formation of these substances appears to depend on the action of sunlight. Reincke thinks that formic aldehyde is present as the most active among these reducing substances, but he does not support this supposition by experimental evidence.

HERREN GOLDSCHMIDT and V. Meyer describe a modification of the well-known apparatus of the latter chemist for determining the specific gravities of gases. The apparatus is filled with dry air, and heated to the temperature at which the determination is to be made; the air is then driven out by a stream of hydrochloric acid, received in a graduated tube standing over water, and measured: the gas under examination is passed into the apparatus, heated, and driven out by dry air into weighed potash-bulbs containing a liquid which will absorb the gas. In this way the weight of the gas is obtained; the volume of air gives the volume of this weight of gas at the observed temperature. The apparatus may also be used as an air-thermometer (*Berichte*, xv. 137).

NOTES FROM THE OTAGO UNIVERSITY MUSEUM

II.—*On the Skeleton of Notornis Mantelli*[1]

HITHERTO the rare flightless rail, *Notornis Mantelli*—the Takahe of the Maoris—has been known only by the two skins now in the British Museum, and by a few fossil bones, found associated with remains of *Dinornis*, *Apteryx*, &c.

Quite recently a third specimen was killed on the eastern shores of Lake Te Anau, and the finder, Mr. J. Connor, not only removed and preserved the skin, but, most fortunately, retained as well the roughly-cleaned skeleton of the trunk. With Mr. Connor's permission, I have prepared a description and drawings of the more important parts of this unique specimen, which is now, with the skin, on its way to England for sale.[2]

The skeleton, consisting as it does, of the parts saved after skinning, is *minus* the skull and anterior cervical vertebræ, the wing-bones, the bones of the legs with the exception of the femora, and the posterior caudal vertebræ. It is in very good preservation, with the exception of the ribs and the femur on the right side, which are shattered, probably by shot, and the right side of the middle xiphoid process of the sternum, which is slightly cut, apparently during skinning.

The more important measurements are as follows:—

	cm.
Length of trunk, measured from the anterior (dorsal) ends of the coracoids to the posterior end of the pelvis ...	18·5
Length of scapula ...	8·0
,, coracoid ...	4·2
,, sternum ...	6·8
Width of sternum, measured just posterior to the coracoid grooves ...	4·3
Depth of carina sterni ...	0·9
Length of ilium ...	10·4
Width of pelvis at posterior border of acetabula ...	5·6
Length of femur ...	10·3

In the vertebral column the nine posterior cervical vertebræ are

[1] Abstract of a paper read before the Otago Institute on September 21, and to be published in the next (13th) volume of the *Transactions* of the New Zealand Institute.

[2] It was much to be regretted that the funds of this Museum did not allow of the purchase of these specimens and their retention in New Zealand. But by the kindness of two ladies, Miss F. M. Wimperis and Miss Maud McLaren, the Museum now possesses the next best thing to the actual specimen, namely, two life-sized oil paintings, executed with a fidelity and artistic skill which leave nothing to be desired. I was the more glad to obtain these pictures, as the Te Anau specimen differs in many details of colouring from the British Museum examples, notably in the absence of the broad black band on the neck and of the crescentic markings on the wing-coverts.

left; there are seven pre-sacral thoracic vertebræ, free save for a union of their several spines by ossified ligaments; the com-

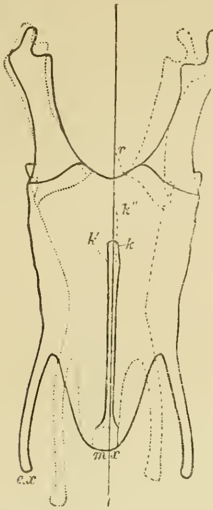


FIG. 1.—Ventral aspect of the sternum and coracoids of *Notornis*, three-fourths natural size (continuous outline); on the left are shown the corresponding bones of *Ocydromus* (dotted outline), on the right those of *Porphyrio* (broken outline), both reduced to the same absolute length of sternum as *Notornis*. *m.x.*, middle xiphoid process; *e.x.*, external xiphoid process; *r*. rostrum of sternum (*Porphyrio*): *k*. point of keel of sternum of *Notornis*, *k'*, of *Ocydromus*, *k''*, of *Porphyrio*.

pound "sacrum" contains one thoracic, five lumbar, four sacral, and six caudal vertebræ. I give no detailed description of the

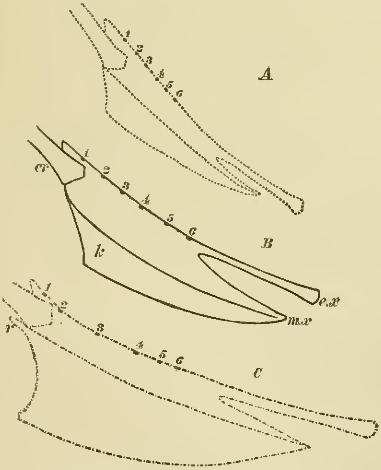


FIG. 2.—The sternum of *Ocydromus* (A). *Notornis* (B), and *Porphyrio* (C), viewed from the left side, and all reduced to the same absolute length of trunk. *cr*, coracoid; *m.x.*, middle, and *e.x.*, external xiphoid process; *r*, rostrum; *k*, keel; 1–6, places of articulation of sternal ribs.

vertebral column, as I could not have it disarticulated; it was, however, quite evident that there was no difference of any importance between the vertebræ of *Notornis* and those of its nearest New Zealand allies, *Porphyrio* and *Ocydromus*.

Of the eight thoracic ribs six are united to the sternum; four of these—the second to the fifth—have uncinate processes, which have a similar position to those of *Ocydromus*, being situated nearer the sternal ends of the ribs than in *Porphyrio*. The penultimate cervical rib is short and stout, quite like that of *Ocydromus*.

The sternum and shoulder girdle and the pelvis are best described by comparing them, point for point, with those of the two allied genera; I am unfortunately not able to include *Tribonyx* in the comparison, as I have not yet succeeded in obtaining a skeleton of it. It is convenient to study the relative sizes and proportions of the bones by reducing the three skeletons to the same absolute length of trunk, as measured from a point midway between the anterior or dorsal extremities of the coracoids to one midway between the posterior extremities of the pubes. The proportions of the individual bones, considered separately or without reference to the rest of the skeleton may be studied by reducing the corresponding bones in the three genera to the same absolute length.

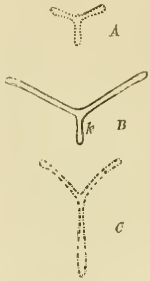


FIG. 3.—Transverse section of sternum of *Ocydromus* (A), *Notornis* (B), and *Porphyrio* (C), showing transverse sternal angle and depth of keel (*k*); three-fourths nat. size.

In all the figures the bones of *Notornis* are drawn with a continuous outline, those of *Ocydromus* with a dotted, and those of *Porphyrio* with a broken outline. In each case also the bones of *Notornis* are three-fourths the natural size, those of *Ocydromus* and *Porphyrio* being reduced either to a common length with those of *Notornis* (Figs. 1 and 7), or so as to correspond with a common length of trunk (Figs. 2, 4, 5, and 6).

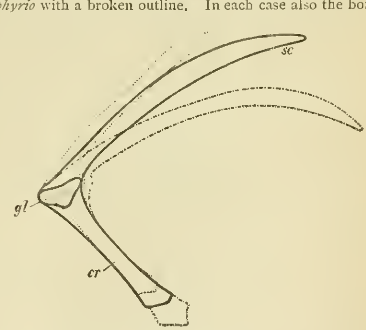


FIG. 4.—Scapula and coracoid of *Notornis* (continuous outline), *Ocydromus* (dotted outline), and *Porphyrio* broken (outline). all drawn to same absolute length of trunk. *cr*, coracoid; *sc*, scapula; *gl*. glenoid cavity.

The sternum of *Notornis* (Fig. 1) is broad and flat, at its anterior end it closely resembles that of *Ocydromus*, having a precisely similar emargination and being devoid of the rostrum (*r*) present in *Porphyrio*; on the other hand, it diminishes very gradually in width from the anterior to the posterior end, and has very divergent external xiphoid processus (*e.x.*); the middle xiphoid (*m.x.*) is blunt and unossified. Relatively to the trunk

the sternum is about intermediate in size between those of *Ocydromus* and *Porphyrio* (Fig. 2). The keel is shallow, like that of *Ocydromus*, having very nearly the same depth proportionally to length of trunk (see table of comparative measurements below); its anterior edge has nothing of the strong forward curvature seen in *Porphyrio*. The lateral curvature of the

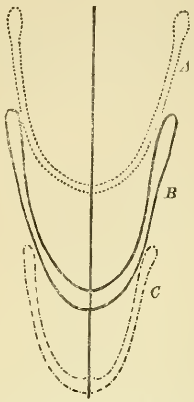


Fig. 5.—Furcula of *Ocydromus* (A), *Notornis* (B), and *Porphyrio* (C), drawn to same absolute length of trunk.

sternum is very slight, its two sides inclosing a dihedral angle—the *transverse sternal angle*, as it may be called—which is very nearly as open as open as that of *Ocydromus*, and many degrees greater than that of *Porphyrio* (Fig. 3).

In the shoulder-girdle both coracoid and scapula are about intermediate in proportional size between those of the two allied

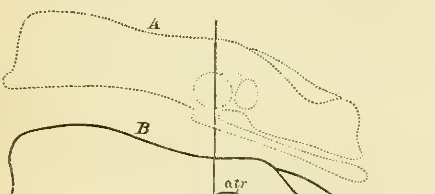


Fig. 6.—Side views of pelvis of *Ocydromus* (A), *Notornis* (B), and *Porphyrio* (C), drawn to same absolute length of trunk. *ac*, acetabulum; *atr*, anti trochanter; *ils*, ilio-sciatic foramen; *ob*, obturator notch; *is*, ischium *pu*, pubis.

genera (Fig. 4). The same is the case with regard to the curvature of the scapula, and the angle inclosed between it and the coracoid—the *coraco-scapular angle*—which in *Nortornis*, as in *Ocydromus*, is greater than a right angle. In this, as in other characters of the shoulder-girdle, *Notornis*, although intermediate between its two allies, approaches most nearly to *Ocydromus*.

The same is true of the furcula (Fig. 5), which is less markedly U-shaped than that of *Ocydromus*, more so than that of *Porphyrio*. It is a very slender bone; the apparent thickness of its median portion in the figure is due to its being flattened in that region from before backwards.

In the pelvis intermediate characters are no longer found, the heavy cursorial *Notornis* having a pelvis of considerably greater proportional dimensions than either of its allies (Fig. 6). Both in vertical height, and in length the pelvis is proportionally markedly larger than in *Ocydromus*, and very considerably larger than in *Porphyrio*. In the relative proportions of the pre- and post-acetabular portions of the ilium, *Notornis* most nearly approaches *Porphyrio*: in the outline of the ilium, as seen from the dorsal side (Fig. 7), it more nearly resembles *Ocydromus*. The excess in size of the pelvis of *Notornis* is most marked in its transverse dimensions, as seen in Fig. 7, where the three pelves are drawn to the same absolute length of sacrum. The ischia and pubes of *Notornis* are widely separated, so much so that the

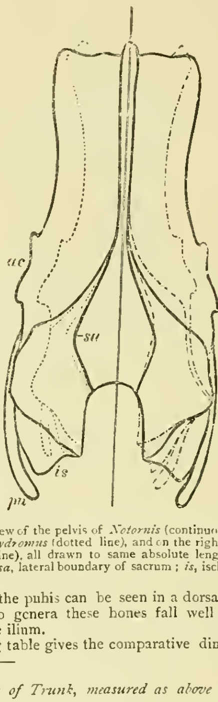


Fig. 7.—Dorsal view of the pelvis of *Notornis* (continuous line) with on the left that of *Ocydromus* (dotted line), and on the right that of *Porphyrio* (interrupted line), all drawn to same absolute length of sacrum. *ac*, acetabulum; *sa*, lateral boundary of sacrum; *is*, ischium; *pu*, pubis.

greater part of the pubis can be seen in a dorsal view (Fig. 7); in the other two genera these bones fall well within the outer boundary of the ilium.

The following table gives the comparative dimensions of the three skeletons:—

Length of Trunk, measured as above = 100

	Ocydromus.	*Notornis.*	*Porphyrio.*
Length of sternum	28	... 36	... 40
Width of ,, measured just posterior to coracoid grooves	14	... 24	... 17
Depth of keel of sternum ...	4·7	... 4·8	... 13
Length of scapula	35	... 43	... 49
,, coracoid	20	... 22	... 28
,, ilium	49	... 56	... 43
Width of ,, at posterior border of acetabulum	21	... 29	... 21
Length of femur	51	... 57	... 51
Coraco-scapular angle	100°	... 97°	... 86°
Transverse sternal angle	141°	... 132°	... 96°

T. Jeffery Parker

Dunedin, New Zealand, November 9, 1881

SCIENTIFIC SERIALS

THE most recent numbers of Trimen's *Journal of Botany* (224-232) run rather strongly on phanerogamic, descriptive and geographical botany. The diligence of English observers seldom fails to add two or three species to the British flora every year, either by absolute discovery, or by the separation of well-marked varieties. Three of these are described and figured in the numbers before us, viz. *Spartina Townsendi*, Groves, *Agrostis nigra*, With., and *Senecio spathulæfolius*, DC. There are various other descriptions of critical forms, and papers on the flora of English districts or of foreign countries; also on British Characeæ, and on marine Algæ new to Devon and Cornwall. Among the more interesting illustrations are two coloured plates of *Cinchona Ledgeriana*, a new species described by Dr. Trimen.—The number for April, 1882, contains an interesting paper by C. P. Hobkirk, on the development of *Osmunda regalis* from the prothallium, and several contributions to the extended controversy on the principles of botanical nomenclature.

THE *Bulletin of the Torrey Botanical Club* continues to be well supported by such writers as Mr. G. Farlow, W. Trelease, T. Meehan, H. W. Ravenel, D. C. Eaton, G. E. Davenport, C. E. Bessey, and others; and indicates the careful manner in which botanical science is cultivated on the other side of the Atlantic. The papers have chiefly a local value, though there are several on morphological points of more general interest.

Bulletin de la Société Impériale des Naturalistes de Moscou, No. 2, 1882.—Studies on the fauna of terrestrial and fluviatile molluscs of Moscow, by C. Milachevitch.—The Amphibiæ and Reptiles of Greece, by Dr. Jacques von Bedriaga.—List of phanerogams and vascular cryptogams observed in the Government of Tula, by B. J. Zinger (with 2 plates).—Materialia ad zoographiam Ponticam comparatam, by V. Czerniavsky (with a plate).—On the phanerogamous flora of the Government of Moscow, by A. A. Fischer von Waldheim.—On Devonian fossils at the Shelon River, by H. Trautschold (with a plate showing the new species, *Tentaculites ghaber*, *Aulopora arborescens*, *Chæteles intricatus*, and *Stromatopora Porchovensis*).—Annual report of the Society, and minutes of proceedings.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 30.—"Description of Portions of a Tusk of an Australian Proboscidian Mammal (*Notelephas australis*, Ow.)." By Prof. Owen, C.B., F.R.S.

The author premised a quotation from the work by Count Strzelecki, entitled "Physical Description of New South Wales, and Van Diemen's Land"; 8vo, 1845, p. 312; in which the Count states that he had bought of a "native," employed at Boree, the station of Capt. Ryan, New South Wales, a molar of a *Mastodon*, of which the vendor stated that "similar ones, and larger still, might be got further in the interior." This tooth was submitted by the Count to Prof. Owen, and was by him provisionally named *Mastodon Australis*. In subsequent extensive correspondence leading to the acquisition of the fossils from a wide range of Australian localities, described in successive volumes of the *Philosophical Transactions*, stress had been laid on the possibility of additional and more decisive evidence of a true proboscidian mammal having left its remains in the formations or caverns whence the marsupial fossils had been derived; but, as more than thirty years elapsed without the acquisition of such evidence, the author could add nothing to Count Strzelecki's original announcement.

Early in the present year he received portions of a tusk discovered or obtained by the late Mr. F. N. Isaac, in a "drift deposit" of a ravine in a district of Darling Downs, about sixty miles to the eastward of Moreton Bay, Queensland, Australia. Prof. Owen had previously received fossils from that gentleman, and the present, apparently Mr. Isaac's latest acquisition, was kindly placed in the Professor's hands by Mr. E. Thurston Holland, nephew of Mr. Isaac.

In his paper the author points out the several characters of true ivory presented by the portions of tusk, including those displayed in microscopic sections. Drawings of these sections, as seen under requisite magnifying powers, and others of the tusk, of the natural size, accompany the descriptions.

The tusk is one from the upper jaw, including a portion of the base and pulp-cavity; and, on the supposition that it has come from a mature animal, it indicates an elephant or mastodon of somewhat smaller size than the existing species of India and Africa.

The wide distribution of elephantine quadrupeds in Africa, throughout an extensive latitudinal range in Asia and Europe, also in both North and South Americas, indicates that at the periods when forest-growths were undisturbed by mankind, the huge quadrupeds deriving sustenance from the leaves, fruit, and tender branches of trees were coextensive therewith. Australia seemed to offer an exception, but the subject of the present paper justifies the belief in the further extension of the hugest land mammals over the tree-bearing surfaces of the earth.

Further quest in the localities indicated by Count Strzelecki, and more definitely made known by Mr. Isaac's discovery, may, it is hoped, be rewarded by the much-desired materials for extending our knowledge of the characters of *Notelephas*.

Mathematical Society, April 6.—S. Roberts, F.R.S., president, in the chair.—Messrs. Buchheim, Muir, and C. Smith were admitted into the Society.—The following communications were made:—The Algebraic solution of the modular equation for the septic transformation, G. S. Ely.—Note on the condensation of skew determinants which are partially zero-axial; and on a symmetric determinant connected with Lagrange's interpolation problem, T. Muir.—On the analogue to the addition-equation for Theta functions, Rev. M. M. U. Wilkinson.—On the general equation of the second degree referred to tetrahedral coordinates, Rev. A. J. C. Allen.—On certain loci and envelopes belonging to triangles of given form inscribed and circumscribed to a given triangle, Prof. Wolstenholme.—On binomial biordinals, Sir J. Cockle, F.R.S.—On the coordinates of a plane curve in space, H. W. Lloyd Tanner.—On Polygons circumscribed about a cuspidal cubic, R. A. Roberts.

Physical Society, March 25.—Prof. Clifton, president, in the chair.—New Members. Mr. M. J. Jackson, B.A., Mr. Nazarus Fletcher, British Museum.—Mr. Shellford Bidwell read a paper on the electric resistance of a mixture of sulphur and carbon. These experiments were begun in December, 1880, to ascertain if the mixture in question was sensitive to light like selenium. Sulphur was melted and mixed with powdered plumbago (the best proportions being 20 parts by weight of the sulphur to 9 parts of the plumbago. The mixture was poured into moulds, and quickly cooled, yielding plates and sticks. When exposed to the light of a gas-flame, an increase in resistance was noticed, and was proved to be due to the heat of the flame, not the light, by experimenting with different sources of light and coloured screens of glass. As both carbon and sulphur decrease in resistance under heating, the opposite effect of the mixture is anomalous, and Mr. Bidwell explains it by supposing that the mixture is mechanical, and that heat expanding the size of the insulating sulphur crystals, separates the conducting carbon particles further apart, and increases the resistance of the mass. Cells of this compound were made like selenium cells by spreading it between the parallel turns of two fine platinum wires wound round a mica plate and the rise of resistance for temperature carefully measured. At 14° C. the resistance was 9100 ohms; at 55° C. it was 5700 ohms, and the rise was in greater ratio than the rise of temperature. Mr. Bidwell also found that these cells would transmit speech when connected in the circuit of a battery and a Bell telephone. They also acted as a thermoscope, when employed after the manner of a thermopile. Mixtures of shellac and graphite, of paraffin and graphite, &c., were also tried with like results. In reply to Prof. Macleod, Mr. Bidwell said the resistance of the cells decreased soon after being made. Mr. Bidwell also stated, that acting on a suggestion of Dr. Hopkinson, he had found that the resistance diminished under a more powerful current force.—Mr. C. V. Boys read a paper on a new method of finding the index of refraction of lenses, based on the general principle employed by Foucault, of causing the ray of light to return on the same path. Prof. Clifton stated that a similar method was now employed by him at Oxford, and was useful for small lenses.—Prof. Fitzgerald, of Dublin, showed mathematically that it was impossible for a small charge of static electricity, carried along by the earth, to move a magnet in its neighbourhood. Prof. Ayrton questioned this conclusion, and exhibited an apparatus intended to test the point experimentally.—The meeting was then adjourned till April 22.

Anthropological Institute, March 21.—Major-General Pitt-Rivers, F.R.S., president, in the chair.—The following new Members were announced:—Messrs. Francis Archer, William A. L. Fox Pitt, W. E. Maxwell.—Mr. Worthington G. Smith

exhibited a measured transverse section through 300 feet of the Palæolithic floor of the Hackney Brook, near Stoke Newington Common. He also showed a collection of ovato-acuminate implements, scrapers, flakes and nuclei from the same spot, all the objects being lustrous and as sharp as on the day they were made. General Pitt-Rivers exhibited and described a large collection of padlocks, showing that the same type had been used in civilised countries from the earliest ages.—Mr. A. L. Lewis read a paper on the relation of stone circles to outlying stones or tumuli or neighbouring hills. The author, from an examination of eighteen stone circles in southern Britain, showed that their builders had in various ways made special references to different points of the compass, but most particularly to the north-east. He then showed from a number of independent sources, ranging from the Prophet Ezekiel down to a foreign correspondent of the *Daily News*, that other ancient structures had similar references, known to have arisen in connection with times and seasons, and various forms of nature worship; that practices connected with such worships, and especially with sun and fire worship, have come down, even in this country, to the present time; and that circular buildings and open circles have been, and are used for worship of this kind; and inferred from these facts that the British stone circles were used for sun worship, probably in the Druidic period. He then dwelt on the references to the North and East in the orientation of English churches, which he thought to be derived from the references to those quarters in the circles, as the Papal churches, whether in Rome or London, are not so placed; and he gave some curious details on this point, and concluded by drawing attention to the firm root taken by Christianity in the Druidic countries of Gaul and Britain, and the great influence exercised by those countries in the later Roman empire, and especially in the establishment of Christianity as the State religion.—A paper was read by Mr. J. E. Price, on excavations of tumuli on the Brading Downs, Isle of Wight, by himself and Mr. F. Hilton Price.

Royal Horticultural Society, March 14.—Dr. M. T. Masters in the chair.——*Australian Fungi:* Mr. W. G. Smith exhibited dried specimens and drawings of grasses attacked by a fungus, from Sussex, and especially Kent, probably new to Britain. It was only known a little more than two years ago. It appears to attack species of *Festuca* chiefly, and is most abundant on sandy soils, not uncommon on chalk, but not on clay. The Rev. M. J. Berkeley described and figured it amongst Australian fungi in the *Journal* of the Linnean Society, 1873, xiii. p. 175, and named it *Isaria fuciformis:* Dr. Cooke now regards it as British. It is said to cause the death of animals browsing upon the grass infected with it.—*Disease of Thujas:* Mr. Smith also exhibited specimens of *T. compacta*, attacked by the Australian fungus, *Capnodium australe*, of Dr. Montague.—*Rhododendrons:* Mr. Mangles exhibited several true species from Sikkim.—*Fritillaria obliqua*, &c.: Several plants were exhibited by Mr. Elwes.—*Leucojgum æstivum*, var., from South France, which flowers two months earlier than the commonform; *Chionodoxa*, var., from self-sown seeds which blossom in two years; Mr. Elwes remarked that its habit has changed, inasmuch as it comes up rapidly and blossoms as soon as the snow is off in Asia Minor, whereas here its progress is delayed to a much longer period, and it is getting longer in this respect every year; *Korolkowia Sewerzowii*, sport., a remarkable *green* flowered branch from what is normally a purple flowering plant. *Tulipa Greggii*, Mr. Elwes remarked how the colour appears to be fading under cultivation.—Dr. Masters exhibited specimens of cones, &c., from trees grown by Mr. Veitch:—*Abies* (*Picea*) *grandis*, *Pinus tuberculata*, the scales being unequally developed on opposite sides of the cone; the seeds of which are believed only to escape after forest fires have taken place. They hang on the trees in many generations even for thirty years.—*Welwitschia seedling.* He also exhibited a dried specimen of a germinating *W. mirabilis*, showing the two cotyledons (deciduous), and the two next pair of (persistent) leaves.—A botanical certificate was awarded to Mr. Veitch for *Pleurothallis glossopogon*, remarkable among its genus for its large flowers, the segments of which are 3 inches in length, broad at the base, and prolonged into a very long slender tail, as in some of the Masdevallias. The lip is small, oblong, chocolate-coloured, with a fringe of hairs at the tip. A similar award was made to him for the beautiful orchid, *Spathoglottis lobbi*, a plant with a very slender wiry flower-stalk, with a single flower, $1\frac{1}{2}$ inch in diameter, clear canary yellow, with broad ovate segments, and a lip with a narrow stalk, and a spoon-shape blade.

EDINBURGH

Royal Socety, March 20.—Prof. Douglas Maclagan, vice-president, in the chair.—Prof. Geikie read a paper on the remarkable series of Carboniferous rocks which are developed in Eskdale and Liddesdale, in the south of Scotland. They form a continuous succession from the volcanic band of porphyrite which overlies the Upper Old Red Sandstone to the Scar limestone of Northumberland. Eleven distinct zones were particularised, of which the fourth and sixth were volcanic (tuff, porphyrite, &c.) These two zones were separated by a bed of fine grey shale, rich in specimens of such marine organisms as Orthoceras, Lingula, Discina, &c., mingled with the remains of fishes, crustaceans, scorpions, and, especially in the upper part, algæ, ferns, lycopods, and other carboniferous plants. Above the latest volcanic platform comes the Gilnockie marine limestone group, which is very similar in appearance and in its fossil contents to the ordinary Carboniferous limestone. This zone dies out to the north-east in Liddesdale, where the cement stone group of Tarras (zone No. 2 of the series) passes into the upper cement stone group (No. 9). The Canobie coal group forms the eighth zone, and, notwithstanding its low position in the Carboniferous series, contains plants of true coal-measure type. Above the upper cement stone group come the Plashetts and Lawsburn coals, which are succeeded on the southern margin of Liddesdale by a conspicuous group of sandstones—the "Fell sandstones." The central part of the thick cement stone groups of Upper Liddesdale must be referred to the same horizon as the Gilnockie limestone; so that the Scottish cement stone group differs from the lower Carboniferous limestones of England in being less marine.—This paper was succeeded by more special papers descriptive of the fossils which have recently been discovered in these Eskdale and Liddesdale rocks: Dr. Traquair treating of the fossil fishes, Mr. B. N. Peach of the Crustacea and Arachnida, and Mr. R. Kidston of the fossil Plants. Several beautiful specimens of scorpions were exhibited.—Dr. J. J. Dobbie and Mr. G. G. Henderson, B.Sc., communicated a paper on the formation of serpentine from dolomite. That such a transformation is probable, had been recognised by many geologists and chemists; but no attempt had been made to point out the precise reactions involved. The explanation given by the authors was as follows: Carbonate of magnesia decomposes at a much lower temperature than carbonate of lime; and hence, in a rock containing these together with silica, and heated to a sufficiently high temperature, the carbonate of magnesia decomposes, silicate of magnesia is formed, the carbonic acid is taken up by water, and so acts as a solvent on the carbonate of lime. Where no water is present, of course the last is not removed.

VIENNA

Imperial Institute of Geology, March 21.—The following papers were read:—C. I. Griesbach, geological sketches from India.—E. Doell, on a fall of meteorites in Europe, and on the shape of the meteorites that fell near Mocs on February 7.—H. v. Foullon, on the eruptive rocks of Montenegro.—R. Zuber, geological notes on the Carpathian mountains of Eastern Gallicia.

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THURSDAY, APRIL 20, 1882

ECLIPSE NOTES

IN the following notes I propose to discuss certain points which in my opinion it is desirable to investigate as fully and as carefully as may be during the coming eclipse.

The magnificent volume which astronomers have received from America during the last year, in which are garnered all the rich results, or most of them at all events, collected during the eclipse of 1878, may really be said to have brought to a focus the chief points of study which are open to us during eclipses. I shall, therefore, use this volume freely in connection with the various branches of research. But still there are points of interest which lie outside this book, for, since the year 1878, I for one, at all events, have been driven to the conclusion that our then views of the chemical and physical constitution of the solar atmosphere require considerable modification to make them accord with the facts.

I have taken many opportunities of showing that the various phenomena observed on the uneclipsed sun are more easily explained if we assume our chemical elements to be dissociated by the transcendental temperature of the sun, than if we hold that their molecular construction is the same there as here.

This question is one, the settlement of which is so important if it can be settled, that if an eclipse of the sun furnishes us with tests, it is our clear duty not to neglect them. I believe that an eclipse does furnish us with two or three such tests, and with reference to one of them, as I wish in these notes to bring together the various statements on the subject which have been made, I will begin by quoting from a discourse delivered by myself to the Astronomical Society last May. (Revised from a report in the *Observatory*.)

"The chemical constitution of the heavenly bodies is a question which necessitates some amount of attention from astronomers. Twenty years ago the observations of Kirchhoff and Stokes enabled us to get glimpses into the chemical constituents of the Sun. Nine years since, though we were in full presence of elements with which we are acquainted, other facts had been registered which exercised the minds of some observers. Kirchhoff's view was that the substances with which we are acquainted were demonstrated in the atmosphere of the Sun by an exact matching, both as regards wave-lengths and intensity, with the lines of certain chemical elements which he employed. Fraunhofer had earlier noted the coincidence of the bright yellow line of sodium with the line D. But Kirchhoff showed that not only in the case of sodium, but in iron, magnesium, and cobalt, and several other substances, there were coincidences which went to show that what was good for sodium was good for other bodies. But nine years ago we had not merely the opportunity of comparing these bright lines with the spectrum of the Sun's atmosphere as revealed by Fraunhofer, but we had the opportunity of studying the spectra obtained by observing very small portions of the solar atmosphere in regions where we should expect an exceedingly high temperature, namely, the inner regions of the solar atmosphere—the regions of spots and the regions of prominences. When we began to tabulate the lines thickened, the thing began to be very much less clear; of the 460 iron lines recorded by Kirchhoff only three were observed in the prominences. Then, when we got indication of a change of refrangibility of the lines due to the motion of the solar gases, we found about the year 1869 that the thickened lines which indicated iron vapour in the spots were not brightened in the prominences, so that a great many questions were raised; and when those questions were raised the idea of decomposition at a high temperature seemed to arise also. I bring before you to-night the results of some purely astronomical inquiries lately undertaken by the Solar Physics Committee. Of course a great many physical inquiries have necessarily entered into the researches. But the astronomical inquiries have had this object in view, namely—given the fact that a high temperature can decompose an elementary body, what happens to the spectra of those bodies when we examine the Fraunhofer spectrum, the spectrum of spots, and the spectrum of prominences? We have had before us the admirable work of Professor Young in 1872, but the work only lasted a month We felt we wanted more facts; so what we have been doing at Kensington during the last two-and-a-half years has been to obtain the spectra of 100 sun-spots—not a perfect record of all lines thickened, but results we could compare with Tacchini's; because, for prominences, we had to depend on Tacchini's observations, observations confined to the brightest lines of the prominences. The Committee therefore attempted something which was quite modest, and contented themselves with observing only the twelve lines most affected in Sunspots. The question was, where to take the lines; and it was obviously the wisest course to take them in the most visible part of the spectrum; so that for two-and-a-half years we have been taking the twelve most widened lines between F and D. I will only trouble the Society with one set of these observations. At the top of this diagram[1] we have carefully chosen among the Fraunhofer lines, the lines stated by Angström to be coincident with the bright lines of iron; and we have given these lines of different lengths, the length representing the darkness of the Fraunhofer lines. In the next horizon we have the actual observations of the iron lines given by Angström, who used an electric arc with thirty or more of Bunsen's cells. We compared the intensities, also represented by length, as given by Angström and as given in the sun. You will see a considerable disparity. Below, we have the lines of Thalén, who used a powerful induction-coil, and the lengths of these also represent intensities. Comparing the Fraunhofer lines and Thalén's lines, you will see a still further disparity between the two spectra. Below, in these 100 horizontal strata are all the observations of the spots taken during the last two years. The first point which strikes one is the enormous number of iron lines, both in the solar spectrum and in the iron spectrum, which are not affected in spots or storms. It is as if on a piano only a few notes are played over and over again, always producing a different tune. The next point is the inversion of the phenomenon. If you examine the lines, you see that every line has been seen without the others. That hard fact is one which really is very difficult to understand, and what strikes one is the marvellous individuality, so to speak, of each of these lines. They do not go in battalions, or companies, or corporal's guards, but in single unities. The great importance of getting these observations was not so much for the observations themselves as for the comparison it enabled us to make with other observations; and naturally the next thing to do was to get a long series of observations of the prominences, because the prominences are hotter than the spots. The spots are caused by down-currents when the Solar atmosphere brings vapour from the cooler regions. They are opposed to prominences, which are ejections from the heated interior of the Sun. We have arranged here the observations of the prominences by Tacchini, since 1872. Here we are dealing with one substance—iron—over a very limited portion of the Solar spectrum; and what is the result? First of all you will see a very much greater

[1] See vol. xxiv. p. 322, Fig. 35.

simplification. The hottest part of the Sun has given us the fewest lines. Next, there is not a single line in common. Passing then from the iron lines in the spots to the iron lines in the storms, we pass from one spectrum

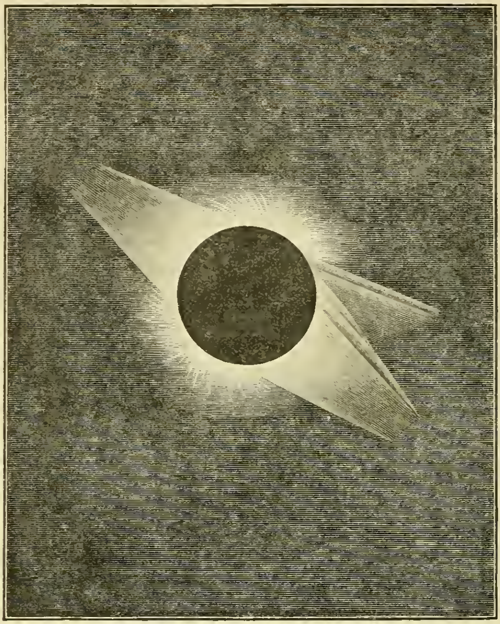


Fig. 1.—The Eclipsed Sun in 1878, from the photographs.

to another, and the two spectra are as distinct from one another as the spectrum of magnesium from that of chlorine or any other substance you please. I have ventured to put in red ink two other lines, because Tacchini

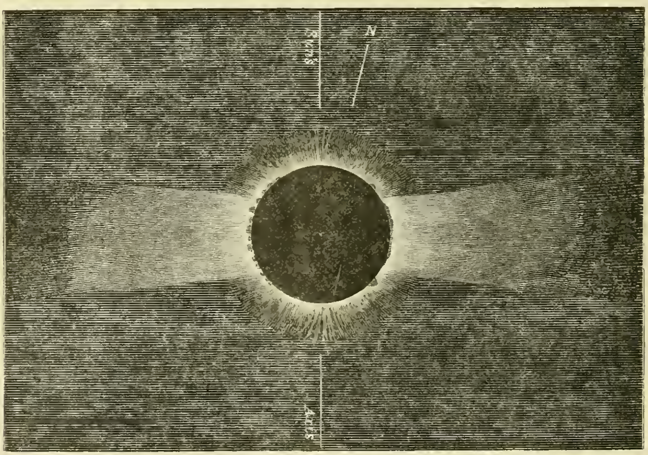


Fig. 2.—The Eclipsed Sun, August 29, 1867, as observed by Grosch at Colchagua, near Santiago.

found that about January 1873 the spectrum suddenly changed when the Sun was absolutely quiescent. There was no Solar rain, and we got the minimum of interference with local temperature. The iron lines van-

ished, and we got two new lines continued through a very long series of observations without any iron line at all; and these two lines have no Fraunhofer lines corresponding with them, nor do they appear in the spectrum of any chemical substance.[1] These phenomena are the last which one would expect. We can understand that differences in the quantity of the iron vapour present would make a certain difference in the spectrum; but we are driven to something quite independent of any change in the quantity of the iron vapour present. What, then, are we driven to? We see with every increase of temperature, passing from the general absorption of the sun to the absorption of the spots and to the radiation in the flames, increased simplicity, just as if a chemist were to talk to us about the action of temperature on substances which he has under control, and say the function of temperature was to simplify. Why, then, if this is the result of the working of temperature, why should not this simplification be due to the breaking up of the iron, if such iron exists at the exterior of the sun's atmosphere, into its finer constituents, as by the solar currents this iron is carried down into more highly heated solar regions? It has been stated there is no necessity for any view of this kind, but that the molecules of iron give out these vibrations, just as a series of bells vibrate differently according as they are struck in different ways. Fortunately, however, we need not have remained so long in doubt on a matter of this kind, because, as early as 1869 observations were made which showed that when the sun is in an excited condition iron vapours are among those vapours which show their motion by a change of refrangibility. So that we had the opportunity of learning whether these really were identical bells, so to speak, being struck in different ways. I think you will acknowledge

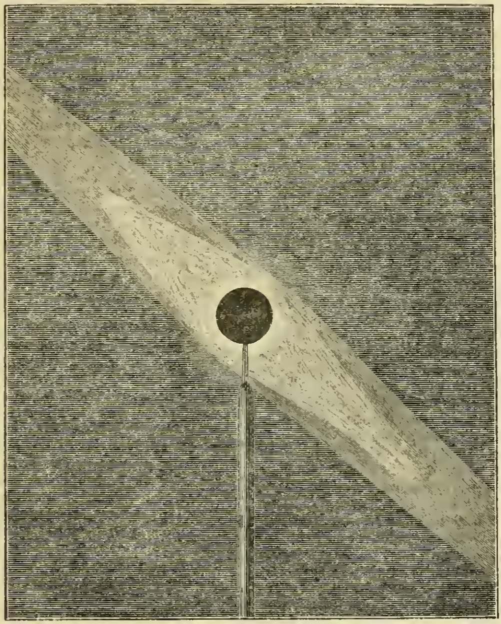


Fig. 3.—Prof Newcomb's observation (pp. 103, 104).

that if we are dealing with bells struck in different ways, however much the spectrum may vary, the molecules should be going with the same velocity. We found, however, when we came to make these observations, that the bells were going with different velocities; so that it cannot, by any possibility, be the same bells which on being struck give us those various notes. In another part of the spectrum these motions have been observed with very much greater success, for the reason that in that other part there are more lines which are observed to indicate considerable motion in Sun-spots. Limiting our observations to lines visible in the same field of view and at the same moment of time, it is a mere toss-up which line of iron shows a descending motion of thirty miles a second, and which line of iron does not move at all, either up or down; so that I think we are justified, so far as these observations go, in considering that there is great probability in favour of the view that we have in these lines, seen in spots and storms, the lines due to the constituents of iron, and not to iron itself, which are competent to resist the transcendental dissociating energies of these hotter parts of the Solar atmosphere. If so, we can bring it to the test; for if we accept any theory of evolution at all, we must imagine that, as our own Earth has cooled down, the Sun is cooling down; and if chemical forms are produced by that cooling, the complexity must be increased by reduction of temperature. If that be so, every reduction of temperature will be accompanied by increasing complexity of chemical forms, and then the highest temperature will be that condition in which we shall have the smallest number of elementary groupings of early forms. Dr. Huggins's work on the stars entirely justifies that view; and I want to point out the kind of test to

[1] See vol. xxiv. p. 368, Fig. 39.

which I allude. If these early forms really exist at the present moment in the hottest portions of the Sun, the spectrum of which is marvellously like that of Sirius, we ought not to expect these early forms to be confined to one of our earthly constituents. But what are the facts? The facts are very precise indeed. On this map we have the result of all the individual observations of the spots and the flames to which I refer. What we find is, that to every prominent line in the spots and in the storms, although these two have no line in common, there is a line common with our present instrumental appliances to iron, vanadium, and chromium, another common to iron and titanium and so forth; and the lines shown by Angström and Thalén, as common to two or more elements, are precisely those lines which are thickened in spots or are brightened in storms, so that the view we have here of early forms of matter is absolutely justified by this massing of lines here and there. We have been able to increase the number of 'basic' lines over this region by observing the lines constantly thickened in the spots. This does away at once with the idea that all these basic lines arise from the fact of the lines being double. For if they are to be doubled there is no reason why the 60 per cent. of lines neglected by the spots and the storms should not have been double lines. But neither Angström, nor Thalén, nor myself have picked up one of these basic lines when we passed from the atmosphere of the spots or the special atmosphere of the flames. Now, there is a moral to this, if you will allow me to enforce it. There is an eclipse of the Sun next year, lasting only, I am sorry to say, a minute and a very few seconds; but there is to be another the year after, lasting nearly six minutes, but it happens to be in a part of the world where it is always afternoon. In the observations of the future we must pay attention to these lines which have been picked out by nature herself in these spots and prominences. If I observed either of these eclipses, I should be content to fix my instrument on three iron lines between 4900 and 5000 ten millionths of a millimetre, because, of these three lines which are in the Fraunhofer spectrum, two have always been seen in spots without the third, and the third has always been seen in the prominences without the other two. If, then, the spectrum of the flames represents the lowest part of the atmosphere, and the spectrum of the spots represents the atmosphere above the flames and below the corona, than we ought to see these lines different in the corona, and in the corona we ought to see the lines which are dropped in these two regions. Of the twelve lines between 4,900 and 4,957, only one is picked out by Thalén for intensification, and that particular line is the line seen alone in the region of the prominences. There are eleven lines which are absolutely untouched by Thalén, showing, that absorption must be proceeding somewhere; and it is most interesting to determine where it is going on. In the Indian eclipse, in 1871, I saw these lines reversed before totality. I saw as it were hundreds of lines; but if I had confined my attention to the three lines I should have got a better idea of what the magnificent flashing out of those lines meant. It has been called the reversing layer; but I do not now believe it is the reversing layer for a moment; for, when it comes to be examined, we shall probably find that scarcely any of the Fraunhofer lines owe their origin to it, and we shall have a spectrum which is not a counterpart of the Solar spectrum."

As further thought led me to believe that this method of observation was one of the most important that could be employed next May, I laid great stress upon it in a memorandum which I subsequently submitted to the Government Committee on Solar Physics, and I pointed out to them at the same time that from what Captain Maclear and myself observed in India in 1871, there was a great probability, that on this question facts might be collected, not only at the exact moments of disappearance and reappearance of the sun, but perhaps even for two or three minutes both before and after totality, by keeping the slit of the spectroscope very carefully on a point where the cusps were narrowest.

The memorandum to which I have referred runs as follows:—

"The total eclipse of the sun which takes place in May next year will be visible in such an accessible region, that it is to be hoped that the precedents of 1860, 1870, 1871, and 1875 will be followed, and steps taken to secure observations, the more especially as the eclipse will happen somewhat near to the period of maximum sun-spots, and will allow of a comparison being made with the results obtained in India in 1871.

"There is one new point (it is not necessary now to refer to the importance of registering the ordinary phenomena) to which I beg to invite the attention of the Committee.

"The discussion of the sun-spot spectra recently observed at Kensington, and of the prominence spectra observed at Palermo by Tacchini, since 1872, throws some doubt upon the validity of some of the conclusions based upon the results obtained by the English and American Government Eclipse Expeditions in 1870.

"In that year, at the moment of the disappearance of the sun, a large number of bright lines was seen to flash out, and it was supposed that these lines composed the spectrum of a thin layer near the sun, and were those the reversal of which produced the lines of Fraunhofer.

"Hence this layer has been termed, and generally accepted to be, the reversing layer. The conclusion seemed to be in harmony with the results obtained by Dr. Frankland and myself, who gave reasons for showing that the region in which the absorption of the elementary bodies of greater atomic weight than hydrogen, magnesium, and sodium must be below the chromosphere. This view was put forward at a time when the elementary nature of the so-called elements was never questioned, and before any of the recent results had been obtained.

"The observations made by the Government Eclipse Expedition which went to India in 1871, showed that this flashing out of lines was a real phenomenon; but as the observation was a general one, and as during the eclipse the Fraunhoferic lines were invisible, there was no absolute demonstration of the identity of the two spectra.

"The facts, now beyond question, that *quâ* the same element, the spectra of spots and flames differ, and that the spectra differ widely among themselves, throw great doubt upon the conclusion to which reference has been made.

"First they seem to indicate that some of the absorption takes place at a higher level than that occupied by the so-called reversing layer.

"Secondly they seem to indicate that many of the brightest lines seen during the flash to which reference has been made may be those seen thickened in spots or intensified in the prominences, although they do not occur except as excessively faint lines among the Fraunhoferic lines.

"In short, in 1870, the fact that the spot and prominence spectra are so widely different from the ordinary solar spectrum, had not received the attention it must receive in the light of the most recent inquiries, and it was taken for granted that because a large number of lines was seen, that therefore they occupied the same positions as the large number of lines which compose the ordinary solar spectrum.

"The recent work seems to show that the complete absorption spectrum of any one element is produced, not at one level, but at various levels, the absorption of all the levels being added together to give us the complete result.

"If this be so, the lines seen in the flash will not all be Fraunhoferic lines with the ordinary intensities.

"A crucial test, which can only be applied during an eclipse, and with difficulty then, will be to observe what happens during the flash to those lines which are specially picked out for intensification in spots and flames. We might expect to see the lines untouched in spots, the lines thickened in spots, the lines brightened in prominences, stretching to different heights.

"They would all appear to rest on the moon's limb, or on the sun's limb, if the cusps can be observed, because we are dealing with the section of a spherical mass, or rather, perhaps, of zones of concentric spherical strata.

"To apply this test under the best conditions, adjacent lines should be taken with cross wires, or some equivalent arrangement adjusted on the corresponding Fraunhoferic lines before totality.

"The iron lines at 4918·0, 4919·8, and 4923·1 will be the best to observe for this purpose, as they are close together, and two are always absent from prominences, and one is never thickened in spots."

When it was decided that an attempt should be made to secure observations of the coming eclipse, the next thing to do was to try to get over the tremendous difficulty that we have always experienced, namely, that during the eclipse itself, the sun's light, and therefore its spectrum, were absent, so that our familiar scale of reference is lost. This is at last got over in a manner so simple that the only wonder about it is that it has not been thought of before. I allude to the employment of a photograph of that part of the solar spectrum which we want, instead of micrometer wires or any other more elaborate means of determining positions, and this method I have already tested, and it works remarkably well.

What is requisite is that instead of a camera replacing the eyepiece it should really form part of it. The plate can be taken away and the eyepiece may be used in the ordinary manner, or a sensitive plate may be placed in it, and a photograph taken. It may then be taken out and developed, half of it wiped off before it is exactly replaced in its original position, and then we have a field of view, the eyepiece never having been separated from the camera during the whole of this time, half of which is occupied by the photograph, the other half with the spectrum of that part of the solar atmosphere which it is desired to study.

The instruments to be used during the eclipse—both telescope and spectroscope—will be identically those with which Capt. Maclear and myself observed the bright lines in 1871, so that instrumentally the chances are good.

I have already pointed out that it is necessary that the slit should lie on the narrowest point of the cusps. To secure this a 3¾′ finder of exquisite definition has been solidly fitted to the telespectroscope with adjustments easy of application which shall insure this result, and in order that the observations may be continuous both in the presence and in the absence of the sun, a diagonal eye-piece with a prism twice the usual size, is employed. This slides easily in two grooves. Half of it is silvered, half of it not, and at the instant of totality the silvered portion is thrown into use.

It is hardly necessary to add that the slit of the spectroscope can be made to lie at any angle from the normal.

So much, then, for one possible test of the new views. There is another—not perhaps quite so direct, but one which it will be still of interest to make. Since 1871, when Janssen made the first observation of this nature, those observers who have studied the spectrum of the corona under good conditions with small dispersion have seen some dark lines as well as the ordinary bright ones, and it has been assumed for the most part that these dark lines are simply the dark lines of the ordinary sunlight reflected to us by particles in the solar atmosphere.

The possibility of putting this question at rest in the most absolute manner by comparing the spectrum of the corona with a photograph of the green part—that is to say, the most luminous part of the solar spectrum (for too much light must not be expected), renders this observation one of importance to make, and, thanks to Capt. Abney's recent researches in the science of photography, it is now as easy, however confusing it may be to those who believe in chemical rays, to obtain a photograph of the green as of the blue, and this will be done before the eclipse.

There is reason to think that if the new views have any truth in them the spectrum of the corona may—I do not say must—give us the ordinary solar lines changed considerably in intensity, but it is probable that this observation will be a delicate one at the best.

But more than our views have changed since 1878. The photographic attack now requires seconds only where formerly minutes were wanted. Nor is this all: the red end of the spectrum awaits a record which it is now easy to secure. Indeed, thanks to Capt. Abney's skill, plates have been prepared which it is hoped will grasp the red and green and blue light with equal vigour, so that one can now more than dream of a permanent record of the whole spectrum from the invisible violet at one end to the invisible red at the other.

We got the first photograph of the spectrum during an eclipse by means of instruments constructed in 1875 for the Siam eclipse in that year. In these instruments I employed a method first used by Fraunhofer, to save as much light as possible. The corona was its own slit and the prism was placed in front of the object-glass, and the dispersion of the prism used was small, because the method was new, the plates were slow, and we were anxious to secure something. We now know that we may safely go ahead, and a prism 3½ inches square in the side, of 60°, will be placed in front of a lens of 22 inches focus.

The length of the spectrum, if all goes well, will be four inches, including the infra-red, which Capt. Abney believes will be recorded in one minute's exposure, and this will be available in an eclipse of 72 seconds.

These extremely rapid plates enable other attempts to be made which formerly would have been considered hopeless. The ordinary photographs of the corona will be taken (by a lens of 5 feet focal length and 4½ inches in diameter) on plates sixty times more rapid than those prepared on the old process. This fact must be insisted upon, because it is evident that the shortness of the totality during the present eclipse is not such a drawback as it once would have been.

Another attack will be as follows:—An image of the sun will be thrown on the slit of a spectroscope by means of a heliostat and condensing lens. The size of the solar image thus obtained will be about ⅛ of an inch. The beam of light will be dispersed by a flint prism of 2

inches face, of 60°, and the spectrum will be brought to a focus on a sensitive plate by a lens of a mean focus of 9 inches. An attempt will be made to secure the whole of the spectrum, and for this purpose the plate requires to be inclined at an angle of 40° to the axis of the lens. The spectrum which it is hoped to obtain by this arrangement would have required an hour's exposure some years ago.

With this instrument attempts will be made to secure a photograph of the flash of bright lines at the beginning of totality, and the spectrum of the corona during totality, an arrangement being made for a comparison solar spectrum after totality by shutting off half of the slit.

So much, then, for the work suggested by applying views and methods which have been broached since the last eclipse.

The remarkable form of the corona, and its still more remarkable extension in 1878, and its great variation from that seen in prior eclipses with a single exception—that of 1867—will render observations of the form and extent of the corona in the present year of the highest importance, even if we had not Dr. Siemens' suggestive hypothesis to lend a more than usual interest to it.

I give an illustration (Fig. 1) copied from the American volume, which I owe to the courtesy of the Superintendent of the Naval Observatory at Washington, to show how my own observations of that eclipse, an account of which was sent to NATURE from America at the time, have been borne out by a discussion of the photographs. Side by side with it, in order that the equatorial extension and the almost identical tracery at the poles can be seen, I give a copy of a drawing made in 1867, both sets of observations having been made four years before the sun-spot maximum (Fig. 2).

Here, indeed, we have food for thought; for the currents in the solar atmosphere, revealed by these drawings, seem to be exactly those demanded by Dr. Siemens; and indeed, his hypothetical diagram which appeared in NATURE a few weeks ago, should be compared with them, in order that the points of resemblance may be grasped.

With reference to the other drawing (Fig. 3), which shows the remarkable observation made by Prof. Newcomb, I cannot do better than make the following quotation from the volume in question:—

"It had always seemed to me that the visual study of the faint outlying portions of the corona would necessarily be interfered with by the brilliant interior portions unless the view of the latter were intercepted. I therefore made preparations to repeat the experiment unsuccessfully attempted at Desmoines in 1869, of hiding the central corona by a screen about 1° in diameter, and examining such portions as might be visible outside of it. The screen now used was made of wood, about 12 inches in diameter, and was mounted on top of a telegraph pole which was set on the elevated ground to the west. The altitude and azimuth of the sun at the moment of central eclipse were carefully calculated, and the screen fixed in such a position that when viewed from the top of a stake driven in the ground alongside of my telescope it would cover the eclipsed sun. The angular diameter of the screen as measured with a sextant from the stake was 57′, its distance was about 60 feet. As this would cut off about 12′ of the corona all round the moon I considered it ample for the purpose, but the results showed that it might well have been somewhat larger.

"I remained in the dark room until about three minutes before the commencement of totality with the view of having my eyes as sensitive as possible. I then walked to the telescope, keeping my eyes partially protected from the light. The lurid colour of the landscape was very striking. The light seemed no longer to be that of the sun but rather to partake of the character of an artificial illumination. This appearance is very readily explicable by the fact that the light coming only from the limb of the sun belongs principally to the red end of the spectrum. As the last ray of sunlight was disappearing I stepped to a stake driven into the ground, the top of which marked the point from which the sun would be entirely hidden by the screen. A bright corona was plainly visible all round the screen, although a portion 12′ from the limb of the sun was entirely cut off. My attention was immediately attracted by a faint blush of light, extending out on each side at an angle of about 45° with the horizon, each end terminating in a long narrow ray. I made a very careful estimate of the length of these rays as 6° from the disc. They shaded off by insensible gradations, and struck me as having a great resemblance to a representation of the zodiacal light on a reduced scale. They were to all appearances continuous with the corona. With a view of judging whether their direction coincided with that of the ecliptic, I tried to judge whether the western one pointed towards the planet Venus, then plainly visible near the horizon. Its direction was apparently very slightly below that of the planet.

"The outlying portions of the corona other than those rays were extremely irregular; that is, there were several rays and other irregularities extending out in different directions. As these were common phenomena, I took no note of their details." J. NORMAN LOCKYER

April 18

(*To be continued.*)

PROF. WIESNER ON "THE POWER OF MOVEMENT IN PLANTS"

Das Bewegungsvermögen der Pflanzen: eine kritische Studie über das gleichnamige Werk, von Charles Darwin, nebst neuen Untersuchungen. Von Julius Wiesner. 8vo, pp. 212. Three Woodcuts. (Wien: Hölder, 1881.)

BEFORE attempting to reply to some of Prof. Wiesner's criticism, it is a pleasure to record my appreciation of the courteous spirit in which his book is written, and the uniformly respectful tone which he employs towards my father. His criticism is so extensive that there is hardly a single point of any importance in "The Power of Movement in Plants" with which Prof. Wiesner agrees. Yet in spite of this far-reaching difference of opinion, he is good enough to express himself warmly as to the value which the book possesses.

Wiesner devotes a good many pages to Circumnutation, and as this phenomenon and the theories connected with it form an important part of "The Power of Movement in Plants," I shall begin with this question. In the first place Wiesner finds fault with one of the methods employed by us in our observations on circumnutation, and gives a diagram (Fig. 3, p. 161) which shows that the method may lead to false conclusions. In the method of observation criticised by Wiesner, the position of the plant at any moment was determined by making a dot on a glass plate in such position that it was in a line with a mark on the organ whose movements were to be observed and with a stationary mark behind or below it. This method is obviously open to objections, and we never ima-

gined it to be strictly accurate; but Wiesner shows that it is possible, by taking some pains, to make it very inaccurate.[1] But the arrangement given in Wiesner's diagram is one which no one would think of employing, if he wished to make the best of the method; in all our experiments we tried, as far as possible, to avoid the extremely oblique arrangement chosen by Wiesner. This may to a large extent be ensured by placing the fixed mark as near the base of the plant as possible, *i.e.* when tracing on a horizontal plane the movements of a vertical organ; if when the stem of the plant is vertical, the index attached to the plant is vertically above the fixed mark, then growth vertically upward will be represented by a single dot. By taking reasonable pains in making some such arrangement, I still believe that no very serious error will be introduced.

In the second method of observing circumnutation, a glass filament bearing two small sights was fixed to the plant, and its position was recorded by making a dot on a glass plate in line with the two sights. Against this method no such serious charges can be brought, and it was largely used, and was, as matter of fact, preferred by us. The methods given by Wiesner are in many ways, no doubt, preferable to those employed for "The Power of Movement," and are in principle the same as that described by me in the *Bot. Zeitung*, 1881, p. 473, which consisted in estimating the actual position of the moving point by means of a vertical microscope; Wiesner has also employed a vertical tube without lenses. In the latter case, the position of the tube is varied until the cross wires are vertically over the observed point, and the various positions of the cross wires at successive intervals of time can be recorded in a way we need not stop to describe. In the case of the microscope the movements are recorded by means of the eye-piece micrometer. This

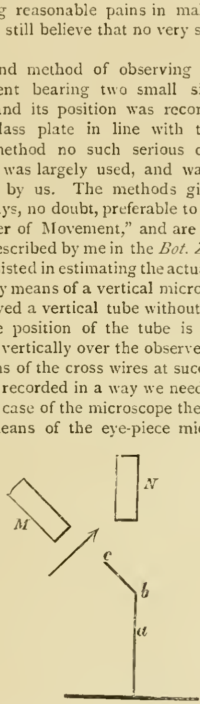


FIG. I.

FIG. 1.—Diagram representing a plant which is supposed to increase in length by the portions *a b*, *b c*. M and N represent microscopes for observing the direction of growth.

method requires to be treated fairly and not to be burlesqued; it presupposes a knowledge of the general direction in which the growth of the organ under observation is proceeding, and the microscope should be parallel to this direction. If as in Fig. 1 a plant grows straight from *a* to *b*, it will be seen by the microscope M, moving in the direction of the arrow;[2] growth from *b* to *c* will not be perceived as lateral movement, but as growth towards the observer, and the same is true *mutatis mutandis* for the microscope N. Thus if we estimate the whole lateral movement which has taken place during the growth from *a* to *c* by the two microscopes M and N, we shall see that they give reverse results. It will therefore be seen that the same general knowledge of the direction of growth is required for Wiesner's and for our method, and that unless this knowledge is properly utilised, either method can be made to give wrong results.

In a notice like the present, it is impossible either to give or to attempt to answer all Wiesner's criticisms, and in what follows I cannot do more than notice what seems to me the more important points. Wiesner states that circumnutation is not nearly so general a phenomenon as we believe it to be. That growth in a perfectly straight line (with a qualification to be mentioned hereafter) is found to occur, and therefore that circumnutation is not an essential quality of growth, is not, in fact, an "Urbewegung" (Primordial-movement).

Let us first consider the circumnutation of roots. The observations given in "The Power of Movements" on this head were made by two methods. In some cases a glass fibre (P. of M., p. 10) was fastened by shellac-varnish to the tip of the root, and the movements of the end of the glass fibre were then recorded by making dots on a glass plate. In other cases the tip of the root was made to inscribe its course on the smoky surface of an inclined glass plane. By this means curious wavy and broken lines were drawn on the glass plates, which we believe to afford evidence of circumnutation. Wiesner confirms the results, but differs entirely in the conclusions which he draws. He believes that the coating of soot is the cause of the apparent circumnutation. He believes that the soot acts injuriously on the root, and causes it to curve away from the injured side, by means of the specialised sensitiveness which, as we have shown, enables a root to curve away when the tip is injured by caustic, &c. He supports this view by an experiment in which (Wiesner, p. 166) the inclined glass plate was coated with *semen lycopodii* instead of soot, and he always found that the course described was a straight unbroken line. This experiment is strongly in favour of Wiesner's view; but, on the other hand, I fail to see how Wiesner's explanation applies to the lateral movements of the root[1] which gives the waviness to the course traced, although it may legitimately be used to explain the movements away from the smoky surface which cause the line to be often a broken one.

The other observations on the circumnutation of roots recorded in "The Power of Movement" are set aside by Wiesner among other reasons, because they were made by fastening a glass filament to the tip of the root, a method which, as he states, disturbs the growth of the root and causes an apparent circumnutation. Moreover, Wiesner's own observations, made with a microscope, lead him to disbelieve in the existence of circumnutation in roots. Wiesner says (p. 174) that the circumnutation of roots is due to the antagonism between geotropism and the natural tendency to curvature existing in the root (Sachs' curva-

[1] It may, however, be observed that if the plant in Wiesner's diagram had grown straight on in the original direction, the tracing given would have been a straight line, and we should have drawn the correct conclusion that the plant was not circumnutating.

[2] Or rather in the reverse direction, owing to the reversal of the image by he microscope.

[1] The lateral movements are probably explained by Wiesner as the result of the antagonism of geotropism and that tendency to nutation which we call Sachs's curvature.

ture). He believes that first one and then another of these forces gets the upper hand, so that the tip of the root moves backwards and forwards.

To this explanation there are several objections. (1) If the root is pointing vertically upwards, as in some of Wiesner's experiments (p. 174), any tendency to spontaneous curvature in the root will assist geotropism, so that any circumnutation that may occur is inexplicable as the result of antagonism of the above-named forces. (2) Wiesner states (pp. 169, 174) that the movements did not take place in one plane: his explanation does not account for this fact. (3) He states (p. 172) that the "so-called" circumnutation takes place in the part of the root which grows most quick. But "Sachs' curvature," which he assumes to be one element in the "so-called" circumnutation, takes place at the base of the root. It is true that it may be said in favour of Wiesner's view that the root may be carried out of the vertical by Sachs' curvature; and if this were the case geotropism would bring it back to the vertical, and thus the direction of the circumnutation would correspond more or less with the plane of Sachs' curvature. But this would not account for movement in any other plane.

Circumnutation of Stems.—Wiesner concludes that there exist stems of plants which certainly do not circumnutate at all. This statement he founds (pp. 176, 177), however, on observations on plants whose line of growth is not a straight line, but is broken by lateral oscillations in various directions. The lateral movements being small and irregular, however, are held not to constitute circumnutation. In one case the growth of the grass seedlings under observation was at first accompanied by the above-mentioned very minute and irregular curvatures, but afterwards seems to have circumnutated in our sense of the term. I shall return again to these cases.

In the case of stems which show the S-shaped curve of "undulating nutation," Wiesner observed the tip (Faba, p. 178) move backwards and forwards in the plane of curvature; this he explains as the summation of the apogeotropic curvature of the lower part of the stem with the nutation (*i.e.* curvature) of the upper part.

Unless I misunderstand Wiesner in this point, it seems to me his explanation does not meet the facts; for I fail to see how *summation* of two curvatures can produce anything, except a variation in the rapidity of the curvature. I cannot see how it accounts for any movement in the opposite direction.

Nor again does Wiesner give any explanation of the movements which he observed in the plane at right angles to the nutation-plane. It should, however, be mentioned that in the epicotyl of the bean, Wiesner observed perfect straight growth after the undulatory nutation had ceased (p. 178).

Wiesner's observations on heliotropism (p. 182) in connection with circumnutation do not call for any special remark. He seems not to have taken the precaution to expose the plants experimented on to a *dull* light, and the plants consequently curved in nearly or quite straight lines towards the light, as occurred in our experiments.

The movements of the flower-head of the daisy (p. 183) Wiesner puts down to the effects of the weight of the flower-head. He also assumes that the circumnutation which he observed in a flowering spike of a Plantago is due to the irregular disposition of the florets on the inflorescence.

Circumnutation of Leaves.[1]—On this point Wiesner's views are briefly:—(1) Some leaves grow in absolutely straight lines without circumnutating. (2) He confirms the *facts* observed by us, namely, that the tip of the leaf does describe the complicated figures described by us as circumnutation, but he interprets the facts differently. He believes that the complicated forces acting on the leaves, viz. epinasty, apogeotropism, apheliotropism, influence of weight, &c., working in antagonism to one another, and alternately getting the upper hand, produce the movements in question.

This argument is one of the most important which Wiesner makes use of, and a careful consideration such as it deserves would require further experiment and observation. It is obviously difficult to distinguish between circumnutation modified by the contending forces, and the same contending forces acting on an organ without circumnutation. One feature in our observations is the almost constant presence of movements in a horizontal plane, movements therefore which cannot be produced by any of the contending forces above described. Against the numerous cases in which sideway movements occur, it may be mentioned that, according to Wiesner, cases occur in which no lateral movements can be observed (p. 192).

This will perhaps be a convenient place to discuss the minute irregular disturbances which Wiesner usually found to exist even where the organ did not properly circumnutate. Let us for a moment compare circumnutation with variability. Modifications of organs are brought about by the summation of small variations in certain directions, and thus we rightly consider variability as the necessary groundwork for modification. But we find some animals, *e.g.* the common goose, which may be almost said not to vary, yet we do not, on the strength of this fact, assert variability is not necessary for modification. No two organs are mathematically similar, yet we cannot draw a distinction between minute irregular deviations from the normal, and such plain deviations as are called variations. In the same way it may be said that no fast and firm line can be drawn between circumnutation and the minute irregular disturbances of Wiesner. We have shown that a true circumnutating movement (as in Brassica) is made up of very small irregular jerks, and this may be given as another reason for believing that the two kinds of movement are only extreme forms of the same phenomenon.

In summing up what he has to say on the subject of circumnutation, Wiesner says (p. 202) that the movements described by us as circumnutation are either disturbances of growth or they are produced by combinations of antagonising forces, *or they are identical with the revolving nutation of climbing plants.* From Wiesner's brief manner of dismissing the last mentioned class, it might be supposed that it has little or no bearing on the question. But this is far from being the case; it is precisely this class to which we attach importance. There can be no doubt that revolving nutation of climbing plants is a development or exaggeration of circumnutation. In the stolons of the strawberry we

[1] It is curious that Wiesner (p. 186) recommends the use of glass fibres affixed to a stem for observing circumnutation, while on p. 187 he suspects that circumnutation of leaves is disturbed by attached glass fibre.

have a mode of growth which may almost be said to be halfway between circumnutation and the revolving nutation of climbing plants. The scattered distribution of climbing plants throughout the vegetable kingdom proves the wide distribution of a form of growth from which revolving nutation is developed—and this form of growth is circumnutation. This widespread form of circumnutation cannot therefore be dismissed as Wiesner has done, since such a treatment of it is quite beside the question.

General Mechanism of Movement.—In "The Power of Movement" we have spoken of the movements of plants as being due to difference in turgescence and in ductility on opposite sides of the moving organ. In it we have pointed out that it is more correct to look at the difference in turgescence than to difference of growth as the primary cause. In this statement "growth" was meant to mean alteration in size due to intercalation of solid particles. If a turgescent stem is allowed to bend heliotropically and is then placed in a salt solution strong enough to destroy its turgescence the heliotropic curvature is in large part destroyed; showing that the curvature at any given moment is largely due to differences in turgescence. Wiesner (p. 33) made the following experiment: he took five seedlings and found that when placed in salt solution (10 per cent.) they became shorter on the average by 1·9 mm.; five other similar seedlings he allowed to grow for $4\frac{1}{2}$ hours, during which time they increased in length by 6·2 mm. (average), Wiesner argues that if the whole increase in length during $4\frac{1}{2}$ hours were due to turgescence, then the shortening caused by salt solution ought to = 6·2 mm. + the original 1·9 mm. which was shown to be in a turgescent state by the former experiment; this, however, was not the case. It would be almost as reasonable to measure the length of an epicotyl in a dormant seed, and to expect that after germinating and growing for a day or two the young plant should collapse in salt solution to the size of the rudiment which existed in the seed. I imagine that it is a generally received opinion, and one which does not require Wiesner's experimental demonstration, that increase of length by turgescence and the intercalation of solid matter proceed simultaneously.

The question, however, need not be considered in further detail, for on this point there is practically no difference between Wiesner's and our own view; he says (p. 35) that "growth is from the first a combination of several processes occurring simultaneously, of which however Turgor is at first the governing one (*vorherrscht*)." This view is the same as that of Sachs ("Lehrbuch," Eng. Tr., p. 712), who describes the interaction of turgescence and intercalation.

Heliotropism.—Wiesner's criticism on the new matter contained in our book with regard to Heliotropism is prefaced by a discussion of some length on the nature, &c., of the phenomena of Heliotropism. There is only one point in this discussion which I wish at present to call attention to. Wiesner holds to De Candolle's explanation of heliotropism, namely, the purely mechanical view that the convex side grows more quickly, simply because it is in shade. As this view does not account for apheliotropism since at least some apheliotropic organs also grow more quickly in darkness than in light, Wiesner assumes (p. 55) the existence, in the fibro-vascular bundle, of negatively heliotropic elements, whose growth is assumed to be favoured by light. It is a pity that this theory has not been at least partly tested by comparing the rate of growth of unicellular apheliotropic organs in light and darkness.

Again the theory seems to require that all apheliotropic organs should be positively heliotropic in light of low intensity; and this, as far as I know, is not the case with the roots of *Sinapis alba*, which I have shown ("Arbeiten des Bot. Inst. Würzburg," Bd. ii., Heft. 3) to be apheliotropic even with very dull light. But I do not lay great stress on this argument, as Wiesner's theory seems to me to rest too much on assumptions to be at present capable of being discussed.

Transmission of Heliotropic Stimulus.—In "The Power of Movement" (Chap. ix.) facts were given that seemed to us to show that one part of an organ may bend heliotropically owing to the illumination of another part, and that, therefore, a heliotropic stimulus is transmittable from one part of an organ to another. The experiment which led to this conclusion is as follows:—A number of small glass caps were prepared, some of which were left transparent, the others were painted black. These caps were then slipped over the tips of seedlings of Phalaris (canary grass), which were thus prevented from bending towards the light, although they did so when the unpainted glass caps were used. The same experiment was made with other seedlings—cabbage among the number. From these results it was inferred that the illumination of the upper part of the plant was necessary to make the lower part bend towards the light; or, in other words, that the heliotropic curvature of the lower part depends on some influence transmitted from the upper and illuminated part. In the case of cabbage seedlings we found that if the lower part is darkened, while the upper is illuminated, no heliotropic curvature of the lower part takes place. Thus we believed that the lower part is in some degree heliotropic, independently of the illumination of the upper part, although the latter is the most important factor in the illumination of the plant. This seems to have been misunderstood by Wiesner, whose criticism is largely directed against what he believes to be our view, namely, that a heliotropic stimulus can be transmitted to a part of an organ which is not itself heliotropic. This misunderstanding on the part of Wiesner is no doubt due to a want of clearness in what we have said on the subject.

Wiesner speaks with great positiveness on this subject, and asserts that he has shown to demonstration that our experiments do not justify our conclusions. He believes that the bending of the lower part of the plants observed in our experiments is due to what he calls "Zugwachsthum" (p. 72), that is to say, the effect of the weight of the upper part of the plant acting on the growth of the lower part. We have discussed the question whether the curvature of the lower part of the cotyledons of Phalaris can be due to weight, and have shown conclusively that it cannot be so ("Power of Movement," p. 469), but Wiesner makes no mention of this experiment. Pots of Phalaris seedlings were placed on their sides so that the cotyledons were horizontal and were at right angles to the direction of the incident light from a bright lamp. Under these circumstances they became bent close to their bases, nearly the whole cotyledon being thus directed towards the light.

This experiment I have repeated since reading Wiesner's book, and have found the results to be the same. The conclusion is inevitable and is in this case absolutely destructive of Wiesner's theory of "Zugwachsthum."

This theory he grounds on the following experiment (p. 69), in which he makes use of Sachs's method of observing heliotropism :—Seedlings growing in small vessels are fixed in the place of the minute-hand of a large clock, so that each seedling is at right angles to the axis of rotation, and rotates like the hand of the clock ; they are then illuminated by light which is parallel to the axis of rotation, and therefore each seedling has one side constantly illuminated by light striking it at right angles. Owing to the constant rotation the effect of weight is eliminated, and thus any curvature which occurs cannot be due to "Zugwachsthum." Wiesner states that whereas the seedlings on the klinostat (Sachs' name for this instrument), were only curved in their upper parts ; plants growing normally without being subjected to rotation were curved down to the ground. This seems at first a conclusive argument against our view, but I shall show that in the case of two plants, cabbage and Phalaris, it is not so.

We expressly stated (p. 479) that our experiments on cabbages were made on young seedlings "about half an inch or rather less in height," because when the plants have grown to an inch and upwards in height the lower part ceases to bend heliotropically. Now Wiesner's experiments were made confessedly on seedlings whose lower part was growing slowly, and which were therefore probably older than those which we employed for our experiments. When Wiesner made his rotating experiment with *young* cabbage seedlings they became curved down to the ground. This proves that the curvature which occurs near the ground in young cabbage seedlings is not due to weight ; and this is the very curvature which we have shown not to occur unless the upper part is illuminated. I do not attempt to explain Wiesner's experiments on old cabbage seedlings, but those made with young ones are alone of importance for us, and they are conclusively on our side.

With regard to Phalaris I regret that I cannot confirm Wiesner's results, who states that these seedlings behaved like the dicotyledons experimented on ; *i.e.* that when grown on the rotating apparatus they do not become bent down to the ground. I have experimented with young seedlings such as we should have used for the experiments on transmission of the light-stimulus, and found that many of them became well bent down to the ground. But it should be remarked that in some cases a certain amount of difference in this respect was observable between the plants on the klinostat and normal ones.

FRANCIS DARWIN

(To be continued.)

OUR BOOK SHELF

Through Siberia. By Henry Lansdell. Two volumes, with illustrations and maps. (London: Sampson Low and Co., 1882.)

IT is obvious that much scientific information cannot be expected from a traveller who was, to use his own expression, "flying across Europe and Asia," and who crossed Siberia from Ekaterinburg, in the Ural Mountains, to Tobolsk in the North, Barnaoul in the Altai, and Nikolaevsk on the Pacific, a distance of 6600 miles, in seventy-eight days, and whose aim was, during this very short time, to investigate the situation of Russian prisons. The author has, however, supplemented his own somewhat superficial observations by information obtained from good sources. The book is provided with many illustrations, partly taken from other works (without quoting the source from which they are taken), and partly from new photographs. These are sometimes very good, but sometimes they convey quite false ideas, as, for instance, the photograph of a "Buriat girl," who obviously is a metis, having very little in common with true Buriats.

P. K.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Limulus

IN a criticism published in the *American Naturalist* for April, 1882, on Prof. Ray Lankester's recent most able memoir, entitled "Limulus an Arachnid," Mr. A. S. Packard, whose most important researches on Limulus are familiar to all zoologists, and to whose courtesy I am indebted for a copy of his criticism, after stating other grounds which lead him to differ in opinion from Prof Lankester as to the close relationship of the King Crab and the Scorpion, quotes in his final paragraphs extracts from published letters written by my late lamented friend and shipmate, R. von Willemoes-Suhm, from on board H.M.S. *Challenger*, at the Phillipine Islands and Japan in February and May, 1875, concerning certain Arthropod embryos which he had had under observation at Zamboangan, and which he then supposed to be the larvæ of *Limulus rotundicauda*. As Von Suhm and I worked together for more than two years daily with our microscopes within two feet of one another, we naturally discussed all that we did and observed in common, and we frequently talked about these supposed Limulus embryos, and looked at them together. It is as well, therefore, since the statements concerning them are being made use of to assist in disproving the position assumed by Prof. E. van Beneden, Prof. Lankester, and others as to the Arachnid nature of Limulus, a position of the strength of which I am myself persuaded, that I should state in print, that long before his death Von Willemoes-Suhm was completely convinced that he had been misled as to the larvæ, and told me that he felt sure they were not those of Limulus at all, but belonged to a Cirrhiped of some sort. I some time ago told my friend, Prof. E. van Beneden, who inquired on the matter, that such was Von Suhm's final conclusion. And I also long ago told Prof. Lankester, and this is no doubt the reason why no reference to Von Suhm's letters was made by the latter in his memoir.

It must be remembered that the only evidence in favour of Von Suhm's Nauplius larvæ being those of Limulus, lay in their general appearance, which simulated to some extent that of an adult Limulus, and in the fact that they were caught with the tow-net in Zamboangan harbour, a locality at which *Limulus rotundicauda* occurs.

H. N. MOSELEY

Oxford, April 15

Silurian Fossils in the North-West Highlands

THE publication of Dr. Heddle's geological and mineralogical map of Sutherland, which was noticed in NATURE, vol. xxv. p. 526, calls to mind some curious points with reference to that region—points on which we should like to have some further and more definite information.

Dr. Heddle quite acquiesces in the general accuracy of the stratigraphical conclusions arrived at by Murchison and his colleagues, and, as may be gathered both from his map and writings, has seen no cause whatever to induce him to believe either in the great fault of Prof. Nicol, or in the unconformity alleged by Dr. Hicks to exist in the adjacent county.

It would seem, therefore, that the chief bone of contention, viz. the age of the great mass of Upper Gneiss, which extends over the central and eastern parts of Sutherland, had been finally and irrevocably decided to be Silurian, notwithstanding the misgivings of the anti-metamorphic school.

There is just one more chance of avoiding the dreaded conclusion, and this "last phase of dissent" has appeared in the form of Dr. Heddle's map and accompanying papers, published in the *Mineralogical Magazine* for 1881. This last phase of dissent so far differs from the others, in that it is not based on foregone conclusions, and does no violence to stratigraphical facts, but is the natural and thoroughly unbiassed outcome of a long series of observations in the field and in the laboratory.

The question now to be solved, stated in the fewest possible words, amounts to this: What is the relation between the fossiliferous limestone of Durness, a limited patch on the north coast of Scotland, and the quartzo-dolomitic series, which, commencing at Loch Erribol, stretches southwards through the counties of Sutherland and Ross in varying phases of development for fully one hundred miles?

If this quartzo-dolomitic series is of the same age, or approximately of the same age, as the Durness limestone, which contains Lower Silurian fossils; then the last phase of dissent is knocked on the head, and henceforth orthodoxy reigns supreme. Aye, there's the rub; and this brings me to the point.

The palæontological facts bearing on this subject require to be re-stated with more confirmatory evidence. We can hardly be satisfied with such vague things as Serpulites, Fucoids, and the like; what is required in the present case is some clear and indisputable evidence that Lower Silurian fossils have been found in any part of the quartzo-dolomitic series away from the Durness basin.

Placing the most implicit reliance formerly in the statements of Murchison, that Orthoceratites had been detected by Mr. Peach and himself in Assynt, and further, that *Orthoceras* had been found in the upper quartz rock of Erribol, the fragment having been identified by Salter as *Orthoceras* (*Cameroceras*) *Brongniartii* (*Q. J. G. S.*, vol. xvi. p. 230), I have felt a little sceptical on the subject lately. Not that one would venture to doubt the perfect good faith of Murchison and his colleagues for a single instant. But it is possible to make mistakes in such matters, and we would wish to see something like a renewal of these alleged discoveries.

Besides it is well known that several eager and experienced searchers have paid visits to the North-west of late years, and, although they found very curious and enigmatical markings in the quartzite series, neither Prof. Blake nor Dr. Callaway, for instance, have succeeded in obtaining a form which could be unmistakably regarded as a Silurian fossil. Moreover, Prof. Blake, who was engaged about the year 1878 in making investigations for his great work on the British fossil Cephalopoda, endeavoured to trace the history of these alleged discoveries, but without success.

Those who may be regarded as Murchison's heirs and successors, must see how vital this point is, and we look to them, not to be content with hunting up old statements as to the discovery of recognisable Silurian fossils, but to afford us the means of satisfying ourselves, beyond the possibility of a doubt, that Silurian fossils do occur in the quartzo-dolomitic series. When this is done, all controversy on the "North-west Succession" should, in the absence of any startling and unexpected discovery, cease; but, until it is done, "the last phase of dissent" will continue to be regarded as a possible explanation by those who are not wedded to any theory, but who require that no link in the chain of evidence shall be wanting. W. H. HUDLESTON

23, Cheyne Walk, S.W.

Magnetic Storm

IT may interest some of your readers to know that a magnetic storm of unusual intensity raged from about midnight of Sunday the 16th to midnight of the 17th. The photographic records are only now being developed, so time will not permit of a detailed account being furnished for this week's number.

We observe a tremendous spot which appeared on the sun's disc first on the 13th, is now rapidly approaching the central meridian, and a group observed on Saturday a little in advance of it, appears to have undergone considerable change in the interval. Possibly those observers furnished with better appliances than we have at our disposal will be able to give fuller information respecting what has taken place on the solar disc during the last few days. G. M. WHIPPLE

Kew Observatory, Richmond, Surrey, April 18

Sea-shore Alluvion—Dungeness or Denge-nesse

As Lambarde points out, lying in Walland and Denge marshes, the "neshe" or Saxon "nesse," a "nebbe" or "nose" of land extending into the sea derived its name from the last marsh—Somner terms it "Stone End"—"Lapis appositus in ultimo terræ." Grunville Collins, in 1693, says, "You may keep within nine or ten fathom of it close to the shoar." Westward of Folkestone great changes have taken place in the condition of the old havens, due to the early accretion and continuous extension up to the present time of this remarkable spit of shingle formed to windward of a tidal estuary. The whole area at the present time between the Royal Military Canal which runs from Sandgate west of Folkestone to Rye, and which forms the base of the Ness, twenty miles in length, and southward to the sea exhibits parallel series of curves running in undulating waves, displaying the periodical accessions to the coast very similar to the annular rings in timber; the surface of which, landward, is gradually brought into cultivation. Lydd, at a comparatively recent period a port, is now three or four miles from the sea. Two natural roadsteads are formed by this spit, in which, dependent on the quarter from which the wind prevails, seven to eight hundred vessels may be seen riding at anchor, lying within two or three miles of Lighthouse Point, the extremity of the Ness.

Numerous projects have from time to time been brought forward for the formation of a harbour of refuge, by running out a pier from the extremity of Dungeness; but having reference to the large amount of speculation as to its origin and progress, the Legislature have wisely hitherto turned a deaf ear to any tampering with a breakwater of nature's forming, affording, as it does, two excellent havens of refuge under certain conditions of weather, for all these shingle nesses possess the remarkable property of creeping across, and having deep water at their extremities.

It has been assumed with some plausibility that the meeting of the tides (which, however, is much further eastward) has influenced its origin. A formation of this description is, however, very little influenced by the tides, and similar shingle spits are found tailing round and across the outfalls of tidal rivers of great velocity, and a similar spit—Langley Point, has formed to the westward under Beachy Head, east of Eastbourne, where there is no such assumed meeting of the tides, and the origin of which may also be traced to a now extinct tidal harbour (Pevensey) to leeward of it.

On the east coast, masses of shingle form similar nesses, such as Landguard Point, inclosing Harwich Harbour, Orfordness, inclosing Orford Haven, and others.

The average progress of Dungeness, in a south-eastern direction has amounted to six yards per annum, and reaching over certain periods an average of eight yards per annum has been attained; this, however, is local, and accompanied by periodical wasting away along the curved bays east and west of Lighthouse Point. This action may be seen in Rye bay, where there is less shingle and more sand by patches of diluvial peat cropping up through the foreshore.

A determinate south-east movement of the extremity of the Ness results from these variations in outline as may be seen on reference to the Ordnance Sheet of H.M. Geological Survey, the position of the old "fulls" to the westward being laid down thereon, indicating plainly the eastern leeward movement.

The following extracts from various hydrographic authorities show the high estimation held for this natural breakwater and its attendant harbours of refuge by naval men.

Norie in his "British Channel Pilot," says:

. . . "You may round this point in 10, 11, or 12 fathoms. The strongest tide runs in 15 fathoms. Ships bound down channel, and meeting here with westerly winds, may anchor to the eastward of the '*Ness*' in 10 or 12 fathoms. . . . You may also anchor to the westward of the 'Ness,' with north-east winds, in 7 or 8 fathoms."

Capt. Martin White, R.N., in his Sailing Directions for the English Channel, says:—

"The West Bay of Dungeness affords good anchorage against north-easterly winds, *and is certainly preferable to Dover Road.*"

"When the wind is between north and by east and west and

by south, the Eastern Bay affords good shelter to vessels of all classes in from 4 to 12 fathoms, and upon pretty good holding ground."

The last edition of the "Admiralty Channel Pilot" says:—

"Off the pitch of the Ness, near the lighthouse, it is steep-to, there being 4 fathoms at 100 yards, and 15 fathoms at 330 yards from the beach. . . . The roads on either side of Dungeness afford excellent and extensive anchorage, according to the state of the wind, with good holding ground, consisting of fine sand over clay and mud."

The Chesil bank, to the West of Portland, in a deep embayment, away from the current of tide, is a remarkable example of the heaping-up power of the wind-waves from the south-west, as it is piled up at the leeward or eastern end, next Portland, 30 feet above high water, or treble the normal height above the sea of such formations.

The Harbour Commission of 1840 reported against Dungeness as a site for a refuge harbour of artificial formation, on account of the continued increase of the spit, as indicated by the necessity for altering the position of the lighthouse, which at its re-erection in 1792 was 100 yards from the sea, and at the period of a then recent survey was 218 yards distant, showing an increase of 118 yards in 47 years. The original lighthouse was, at the erection of its successor in 1792, 640 yards from the shore. The Harbours of Refuge Commission of 1844 also reported on it, referring to its excellent anchorage, and the danger of interfering with nature in such a spot. The changes in this remarkable formation have been so extraordinary, as fully to endorse these official conclusions, and the various vicissitudes it has undergone demand more careful consideration than is usually afforded by those who advocate artificial works, the effect of which on these nicely-balanced movements would possibly be as problematical as the turning of these shingle "fulls" into quarries for building purposes would be suicidal, and either course might result in a baneful interference with one of the finest natural breakwaters on our coasts.

J. B. REDMAN

Dispersal of Bivalves

REFERRING to the fact mentioned in Mr. Darwin's letter, that mussels are sometimes brought up on the point of a hook, it is common, in shell collections, to find "Heart Cockles" (*Isocardia cor*), which look exactly as if they had been drilled each with a small hole, centred at some point in the opposed edges of the two valves.

These specimens have been taken by the long-line fishermen on the Irish coast, and the apparent puncture is caused by the animal having closed upon the shank of an accidentally intrusive fish-hook with such force as to crush the edges of the shell against the steel wire.

Numbers of this comparatively rare species have been thus procured, for Isocardia will allow itself to be drawn in with the line rather than open its doors to new possibilities of danger while the hook is within.

D. PIDGEON

Holmwood, Putney Hill, April 12

The Yellow River and the Pei-ho

As bearing on the subject of my paper on the hydrology of the Chinese rivers, which was published in NATURE (vol. xxii. p. 486), I take it upon myself to forward the substance of some observations made by Mr. T. W. Kingsmill—president of the North-China branch of the Royal Asiatic Society—at a meeting of the Society in September, 1880.

Having made measurements of the cross-section of the Yellow River, and having obtained the most reliable information he could gather regarding the depth of water and the speed of the current at different seasons, Mr. Kingsmill roughly estimates the discharge as follows:—

Extreme low water	18,000 cubic feet per second.
Ordinary ,, ...	36,000 ,, ,,
Flood discharge	112,000 ,, ,,

The average discharge he is inclined to estimate at about three-fourths of the single estimation supplied in Sir George Staunton's narrative; and he places it at, or rather surmises that future careful observations will estimate it to be, 300,000,000 cubic feet per hour, or about 83,000 cubic feet per second.

With reference to the Pei-ho, Mr. Kingsmill, from an observation made in the summer of 1879, estimated its water-discharge at 9000 cubic feet per second. My own estimate was confined to the winter months; but for reasons given in my paper I considered it fairly typical of the whole year, viz. 7700 cubic feet per second. That I was justified in so doing, this independent observation of Mr. Kingsmill sufficiently proves.

H.M.S. *Lark*, Auckland, February 28

H. B. GUPPY

Table of the Appearance of Rare Lepidoptera in this Country in Connection with the Sun-Spots

THE following table is a numerical abstract of the records relating to the capture of certain rare lepidopterous species in the United Kingdom, condensed from a larger table presenting an abstract of the pages of the *Magazine of Natural History*, *Zoologist*, *Entomological Magazine*, *Entomologist*, *The Entomologist's Weekly Intelligencer*, *Naturalist*, *The Entomologist's Annual*, *The Yorkshire Naturalist*, *Newman's British Butterflies*, and other works. It will show the relation existing between the sun-spot cycles and the appearance of the species, yet not quite so distinctly as my larger compilation, since, in order to adapt it to the pages of NATURE, it has been necessary to equalise the sun-spot cycles, which has caused, I fear, a certain overlapping of the cycles of capture, which really are well defined. I was not aware until quite recently that any one had been before me in this branch of entomology, but I now find my remarks in the *Journal of Science* for August, 1881, corroborated in a previous publication (Dr. F. G. Hahn, "Ueber die Beziehungen der Sonnenfleckenperiode zu meteorologischen Erscheinungen," pp. 155-157, Leipzig, 1877). This pamphlet is noticed (E. D. Archibald, NATURE, vol. xix. p. 145, article, "Locusts and Sun-Spots").

Years.	Sphinx Convolvuli.	Deilephila Galii.	Deilephila Livornica.	Chærocampa Celerio.	Chærocampa Nerii.	Colias Edusa.	Colias Hyale.	Argynnis Lathonia.	Vanessa Antiopa.	Pieris Daplidice.		
1832, 43, 54, 65	1	1	4	25	2	309	62	16	13	—	433	m
1833, 44, 55, 66	1	2	1	1	2	382	71	3	1	—	464	m
1834, 45, 56, 67	23	14	11	16	6	117	18	10	5	1	221	m
1835, 46, 57, 68	735	14	40	14	4	440	1109	136	79	12	2583	+
1836, 47, 58, 69	121	7	5	1	1	116	6	48	14	6	325	
1837, 48, 59, 70	162	233	30	3	2	95	13	10	3	9	560	M
1838, 49, 60, 71	20	3	20	11	1	345	7	3	1	8	419	M
1839, 50, 61, 72	5	—	2	5	—	80	47	308	7	3	457	
1840, 51, 62, 73	9	3	8	—	2	5	5	20	—	—	52	–
1841, 52, 63, 74	—	—	—	2	—	9	—	27	5	4	48	–
1842, 53, 64, 75	162	—	1	11	1	67	213	9	—	1	465	

The numbers give the amount of captures in the years specified; but in the case of *C. Edusa* and *C. Hyale* a 10 has been placed for every notice of "abundant," a 5 for every notice of common, the number of captures not being often stated.

Abbreviations employed + maximum appearance, – minimum of appearance, *m* minimum of sun-spots Wolf, M maximum of sun-spots Wolf.

A. H. SWINTON

Binfield House, Guildford, March 23

THE APPLICATION OF ELECTRICITY TO SHIPS' LOGS

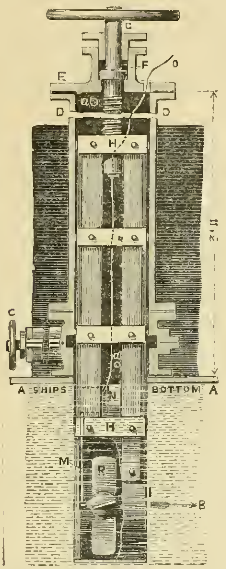
THESE are days of rapid scientific progress, and the great interest so recently excited by the application of electricity, in a new and startling way, to transmit information, has been almost eclipsed by the attention which its use for lighting and the transmission of power has attracted. Though no longer confined to signalling, yet this is still its most important use, and one for which its employment is being extended in many directions, always with the most satisfactory results. It is with the application of electricity this fleet messenger for giving a constant record of the rate of a ship, that this article is concerned. Before, however, dealing with this matter, it will be well to say a few words about logs generally.

Ordinary ships' logs are of two kinds, called respectively harpoon and taffrail logs. Harpoon logs, which are the more extensively used, consist of a cylinder, on one end of which works a fan or screw, registering the number of revolutions by means of clockwork within the cylinder, the dial being visible through a glass face. To the other

end, which is conical, a rope is fastened, so as to enable the log to be towed by the ship. A modification of this is called the "detached" log, the revolving fan and case for the clockwork being two separate pieces. To both these logs there are several objections, such as the almost unavoidable entrance of salt water to the wheelwork, the drag on the ship, which is often as much as 40 lbs. or more, the inconvenience of hauling in the log each time it has to be read, and lastly, the loss of the whole instrument, should the towing-line break.

To obviate these objections, the taffrail log was invented, and which goes a step further than the detached log, by taking away the recording portion to the taffrail of the ship, and causing the towing rope to transmit the revolutions of the fan to it. These logs are, in many respects, a great improvement on the first; the registering dial is less liable to damage, and is always visible; the tension of the towing line is less; it is therefore less liable to rupture, and even when this does take place, the fan is

FIG. 1.



easily replaced. On the other hand, the unsuitable nature of the towing line for transmitting torsional force, is obvious. Further, the slip of the fan must by seriously affected by the constant variation, in length, of the submerged portion of the line. In Walker's log these difficulties are partly met by the use of a governor, consisting of a pair of weights fixed to the towing line, and revolving with it; but this device can only modify the evil.

The late Mr. W. Froude, who pointed out other objections to existing logs, endeavoured for some time to devise an electrical log, in which the revolutions of an accurately formed screw should be communicated to the deck, *not* by the revolution of the towing rope, but by an electric current in wires carried by it. Eventually he succeeded, in conjunction with Mr. Brunel, in constructing an instrument of this kind, which was applied to Sir W. Thomson's yacht, *Lalla Rookh*, and worked very well, till by some mischance, it carried away and was lost. Mr. Kelway had, meanwhile, been working independently with the same end in view, and had constructed an electric log, which he brought before the notice of the Admiralty. A trial of this last instrument was undertaken by Messrs. Froude and Brunel, on board H.M.S. *Shah*. In this trial, the registering portion was placed on the poop, and self-recording apparatus was used, by which at every revolution of the fan a pen was lifted from a strip of paper moved by clockwork, thus causing breaks in the otherwise continuous line. On a line parallel to this, time in half seconds was simultaneously recorded. The result of this trial was to clearly demonstrate the satisfactory action of Mr. Kelway's log, and it was afterwards applied, together with accurately formed fans, to H.M.S. *Iris*, and the yacht *Alberta*. Its further extension has not been proceeded with, apparently in consequence of Mr. Froude's decease. Quite recently the same inventor has put into practice the happy idea of placing the electrical log to work altogether under the ship's bottom. The way in which this is done is shown (Fig. 1). A water-tight case is securely fixed to the bottom plates (AA), in this case a frame (HH) is moved up and down, and in the lower part of the frame the fan (R) works. The fan communicates its motion by a vertical spindle (M) to a box (N), in which electric contact is made and broken eight times in a mile. The wire (OO) can thus transmit a record of the distance passed over to a dial or dials fixed in any part of the ship.

This invention has the advantage of allowing the screw of the instrument to work in water of uniform pressure, and to a great extent free from the disturbing action of the waves. There is undoubtedly a body of water carried along by the surface friction of the ship. The depth to which this extends is unknown, but there is strong reason to think it is very small, and would not therefore affect the fan. The log itself, however, offers an excellent opportunity of investigating this obscure point, since it can easily be raised or lowered to different positions.

The complete instrument is at present being exhibited at the Crystal Palace Electrical Exhibition, and an account of its various applications has been recently given in a paper by Mr. Kelway. These applications are many and important, and the invention, besides being very suitable for its original purpose, promises to afford valuable information, not to be obtained by the use of ordinary logs. H. S. H. S.

THE TONNAGE QUESTION

ONE of the most interesting papers discussed at the recent meeting of the Institution of Naval Architects was on the Revision of the Tonnage Laws. The author, Mr. W. H. White, is, from his position as Chief Constructor at the Admiralty, as well as from his well-known attainments, a singularly impartial and able judge of this most difficult question. The occasion which called forth the paper was the report on the tonnage question lately issued by the Royal Commission, which last year took evidence on this subject. The report was, as is well known, not signed by all the commissioners. Two of them, viz. Mr. B. Waymouth, Secretary to Lloyd's Register, and Mr. Rothery, Q.C., the Wreck Commissioner, wrote independent reports, which differed widely from that of the majority, and from each other.

The state of the Tonnage Laws has for a long time past given rise to serious complaints, on various grounds. As matters stand at present it is possible for a steamer not only to have no tonnage at all, but even, as is the case of a vessel well known on the Clyde to have a negative tonnage. It is also alleged that the indiscriminate measurement of all inclosed spaces on deck for tonnage has a direct tendency to produce unsafe vessels, by taxing the covering in of the large open spaces above the engine, &c., and also by unduly taxing vessels provided with hurricane decks, which, from their nature, can never be entirely filled with cargo.

Mr. White, in his paper, reviews the whole question historically. He begins by propounding the question, should *internal capacity* be still retained as the basis of measurement, regard being had to the present conditions of trade and shipping? He shows that some of the earliest tonnage laws on record had this basis, such for instance as the French Ordonnance de la Marine of 1681, and the English law of 1720. The vessels to which these laws applied were mostly engaged in the wine and spirit trade, and the measure of 42 cubic feet to the ton, which was the basis of the law of 1681, very approximately expressed the dead-weight capability of the ship as well; for 42 cubic feet were allowed for stowing four bariques of wine, which weighed approximately one ton. Thus the vessels measured by this rule were enabled very approximately to carry as many 20 cwt. tons as they contained tons of cubic capacity. The principle of measurement by internal capacity, as now accepted, was not adopted till the year 1833. In 1836 the New Measurement Law, proceeding on these lines, was passed, and in 1854 came the more perfect Merchant Shipping Act of Moorsom. In framing this law, two fundamental conditions were accepted:—

First, that the taxable tonnage of a ship should be represented by her freight-earning power.

Second, that the space available for the conveyance of passengers and cargo should be taken as the measure of freight-earning power.

The great question of the moment is, whether the changes in the construction and propulsion of ships made since 1854 have not necessitated some modification of the doctrine that internal capacity is the fairest measure of the possible earnings of most ships. Mr. White thinks that this is scarcely a matter for argument, it being generally admitted that in the great majority of ships of the present time, the limit of freight-earning is the dead-weight capability. He points to the awning deck class as a case in point. "It undoubtedly has much to recommend it as regards safety and good behaviour; yet it appears that the internal capacity is so great in proportion to the carrying-power, that the whole available space can never be utilised, even when the lightest cargoes are carried."

In support of this view Mr. Waymouth stated that the "aim of the ordinary ship-owner is to have a vessel which will carry as many 20 cwt. tons upon as few 100 cubic feet tons (on which he pays his tonnage dues) as he possibly can." It is, as Mr. White points out, perfectly obvious that the number of 20 cwt. tons in a given ship depends upon the load-line, and that consequently there is a close connection between tonnage legislation and load-line rules, so much so, that contrary to the opinion of the majority of the Commission, the two questions should be considered together.

The majority of the members of the Royal Commission were averse to any change in the present principle of measurement by internal capacity, for reasons which are stated at length in their report, and which are nearly all founded upon the inconvenience which would result from any change to foreign countries which have copied our Tonnage Laws, and to the various port and dock authorities throughout the world. Though averse to any change in principle, they yet recommended certain amendments to the existing law, which related chiefly to the deductions which should be allowed from the gross tonnage, and also as to the mode of measuring the tonnage of iron ships, particularly of those having cellular double bottoms. Regarding the deductions from gross tonnage, it is to be noted that no provision has been made for the case of awning-decked vessels. Also the Committee was of opinion "that the exemption of any closed-in space from measurement into tonnage, as an inducement to owners to increase the safety of ships is unsound in principle, and if adopted would have to be followed by new restrictions upon which fresh complaints would be founded." This is an alternative which in our opinion is preferable to continuing regulations which admittedly discourage the building of safe types of ships.

The proposals of the Commission as to the measurement of the tonnage space of cellular double-bottomed ships appears to us to err in the same direction. If their recommendation were carried out, part of the space between the double bottoms would actually be included in the space available for tonnage measurement. Now it is absolutely impossible to carry freight between the double bottoms, and on the other hand, vessels built on this system are the strongest afloat; consequently the recommendation is not only a violation of the principle of the Act of 1854, but also unfairly handicaps this excellent type of ship.

It will thus be seen that the majority of the Royal Commission recommend that things should be left as they are, subject to certain amendments in detail, some of which latter appear to be wrong in principle, and are moreover unpopular with both builders and owners.

The alternative proposal made by Mr. Waymouth was that dead-weight capacity should be adopted as the basis of measurement. His proposals are summarised in the following words:—

"I propose that the total dead-weight carrying capability of a vessel should be ascertained, and also the line to which she is immersed when equipped ready for sea, without cargo on board. In the case of a sailing vessel there should be no consumable stores on board, and similarly in a steam vessel, the engines should be complete, and the boilers full of water, but there should be no coals on board. Under these conditions it is considered that steamers would be in a relatively fair position, one against another, and also in relation to sailing vessels.

"The dead-weight required to immerse a vessel from the light line to a maximum load line fixed by authority, would denote her utmost carrying capability (in tons of 20 cwt.), compatible with safety in ordinary circumstances.

"There is a growing disposition, on the part of ship-owners, to regard with favour the fixing of such load line, provided that the authority on whom the duty would devolve be so constituted as to inspire confidence in its decisions."

Mr. Waymouth's proposal would, if adopted at once get rid of an enormous mass of difficulties. On the other hand, the fixing of a load-line would be certain to give rise to numerous disputes, and moreover, though doubtless applicable to the majority of merchant steamers, the dead-weight system would not apply to passenger steamers.

Mr. Rothery's proposal was of quite a different nature. It is at least open to doubt if the principle of the Act of 1854, viz. that the freight-earning capability of the vessel should be the basis on which to assess her taxable tonnage, is correct. It is not by any means clear that there should be any connection whatever between the two. There is another principle which has much to commend it from the common-sense point of view, viz. that the service rendered to the vessel by the institution to which she has to pay, should be the basis on which to calculate the payment. This is the view adopted by Mr. Rothery in his report. Now, in the case of a dock or port, the service rendered to a vessel for accommodation is proportional to the space which she occupies in the water, and to the length of time which she occupies it. The exact space occupied by a vessel in the water is proportional to her displacement, and hence Mr. Rothery proposes to adopt the system of displacement tonnage.

Mr. White does not enunciate any views of his own as to the best basis on which to assess the dues, in the event of a revision of the present law. It is not, however, difficult to perceive that he favours the principle of

service rendered to the vessel, and not the freight-earning power as the basis of assessment. Mr. White differs, however, from Mr. Rothery in the mode in which the space occupied by the vessel should be measured. He considers that for all practical purposes this space is equal to the parallelopipedon formed by the extreme length, extreme breadth, and the mean draught, and consequently thinks that "parallelopipedon tonnage," as it is called, has much to recommend it. The possibility of berthing other vessels at the same dock or wharf is not sensibly altered by the under-water shape, consequently the above seems a fair measure of service rendered.

Mr. White does not consider that the above proposal would lead to the adoption of a box-shaped type of vessel. He thinks that the cost of propulsion of a steamer would effectually check any such tendency.

Mr. White concludes his most able paper by the following piece of advice, which we trust may be taken to heart by whatever government finally undertakes to revise the tonnage laws.

"In conclusion, I would venture one remark respecting the course of procedure which promises to give the best results, if a revision of the tonnage law is decided upon. Valuable as the labours of committees and commissions may be in testing the feeling of those interested in shipping, and putting on record the opinions of competent authorities who view the subject from different standpoints, it does not appear that a satisfactory revision can be looked for in this direction. The precedent to be found in the preparation of the law of 1854 seems to be a good one. Following after the work of the commissions came the careful, extensive, and laborious inquiry of Moorsom, a scientific expert, having a thorough acquaintance with the subject, and placed in direct communication with the shipping community. If the long-talked-of Central Council or Advisory Board should be constituted to deal with matters relating to the mercantile marine, and if it should be assisted by a competent scientific staff of naval architects, we may hope that, among other much-needed action, will be included the revision of the tonnage laws in a sense that will give more general satisfaction than could otherwise be obtained."

THE NAVAL AND MARINE ENGINEERING EXHIBITION

THE Exhibition which Mr. Samson Barnett, jun., has opened at the Agricultural Hall, and which closes to-day, contains a very large number of objects connected directly and indirectly, and sometimes even totally disconnected with naval purposes. The collection is by no means totally devoid of novelties and of objects of considerable scientific interest. The Exhibition contains numerous models of recently-built war and merchant ships, a few small marine engines and boilers, and portions of large-size marine boilers, together with fittings of engines and boilers in great variety. There are also several specimens of steam steering gear, ships' telegraphs, steam capstans, cranes, and machinery generally for loading and unloading vessels, boat-lowering apparatus, life-saving appliances, dredging gear, and refrigerating appliances. Naval artillery was not well represented, but Messrs. Hotchkins and Co. exhibited some fine specimens of their beautiful revolving cannon, which have been adopted in the navies of several foreign governments, notably in those of France, Germany, Russia, and Italy.

The ships' models are as a rule very deficient in interest, in spite of the fact that they represent many of the most famous of modern vessels, such as the *Devastation* and *Polyphemus*, among men-of-war, and the *Servia*, the *City of Rome*, and the *Ravenna* amongst passenger steamers; for they were mostly half models of the outsides of the vessels, which, though they give a very good idea of the exterior form, afford no information as to the construction, the interior arrangements, or the engines and boilers. This is somewhat disappointing when we remember what strides have been made in recent years in the construction of iron ships.

In the Department of Marine Engines and Boilers there was a remarkable absence of models, or even of drawings of the very fine engines with which our first-class war and merchant steamers are now fitted. By far the most important objects exhibited in this section were the magnificent flanged front plates of boilers, one of these being fifteen feet in diameter, and made in a single piece, with three flanged openings for furnaces, from a single 3-ton ingot of Siemens' steel. The same firm also exhibited several specimens of Fox's corrugated furnaces, an invention which has conferred the greatest benefits on the cause of steam navigation, by rendering possible the use of the very high boiler-pressures which are so essential to economy of fuel. Mr. David Joy also showed a model of his own celebrated valve-gear, which has given such excellent results with locomotives at Crewe, and which will doubtless soon become favourably known to marine engineers. This valve-gear is probably the most serious competitor to the old link-motion driven by eccentrics, first adopted by Stephenson for locomotives, and which has remained in pretty general use up to the present time. Mr. Joy's motion, besides being simpler, effects a better distribution of the steam, in many respects, than the link-motion.

Amongst the most interesting features of the Exhibition were the refrigerating machines. Of these there were four, exhibited by Messrs. Bell-Coleman, Messrs. T. Pigott and Co., the Haslam Foundry and Engineering Company, and Messrs. J. and E. Hall. As we have so recently described the principle of action of these machines, it will not now be necessary to go into details. It may, however, be mentioned that they are at the present moment being used by the Peninsular and Oriental, the Cunard and the Orient Steam-ship Companies, and also by the London and St. Katharine Dock Company, and the Orange Slaughtering Company. The successful application of mechanical refrigeration to the preservation of fresh meat and other provisions, is a subject of such immense importance, that we are not surprised at the great interest excited by these machines.

Amongst the miscellaneous exhibits we can specially mention the numerous collapsible and other life-boats, and the boat-lowering apparatus, some of which are really admirable. Also the wire-rope rigging, and the stout wire torpedo nets, exhibited by Messrs. Bullivant and others.

It seems a pity, considering the great amount of interest which has been excited by this Exhibition, that it should only remain open for ten days.

TOTAL ECLIPSE OF MAY 17

WE have given from time to time, in the Astronomical Column, particulars of the approaching total eclipse, pointing out that it is visible at a point on the Nile, in lat. 26° 32′ N. We are glad to be able to state, that an expedition left this country yesterday with the view of obtaining photographic and spectroscopic observations. The expedition has been organised by the Science and Art Department and the Royal Society combined, on the recommendation of the Solar Physics Committee.

The expedition sails to Suez in the Peninsular and Oriental steamship *Kaisar-i-Hind*, and a good idea of the local arrangements made will be gathered from the accompanying article, which we reprint from the *Daily News* of yesterday:—

May 17, 7 a.m., sun eclipsed, visible at Greenwich. Thus runs the records in our pocket-books. So short,

sharp, and decisive, that to talk about an eclipse expedition in connection with it seems at first sight an absurdity, unless indeed we dignify by that name a jaunt in a penny steamer to Flamsteed's famous hill. Thanks, however, to School Boards, boys' clubs, and the like, the explanation will be apparent to everybody, and it is this. For, although on the 17th of next month the moon will come between us and the sun in such a way that part of the sun will be covered at Greenwich, which may be taken as a short title for the British Islands, the covering-up will not be total, and we shall have, therefore, only what is called a partial eclipse, hardly worth looking at, from the physical astronomers' point of view. But a thin line can be drawn on the globe from the West Coast of Africa, through Egypt, Persia, Central Asia, and China, along which the moon will entirely cover the sun; and here, instead of a partial eclipse, we shall have a total one.

This is one of the most important phenomena we can observe in the whole domain of physical astronomy, for a reason with which the readers of the *Daily News* are already familiar, namely, that when the light of the bright interior nucleus of the sun which we usually see is prevented from illuminating our upper air, by the interposition of the dark moon, the sun's atmosphere, which we never see except at such times, is revealed in all its majesty, and invites study on the part of those who care for the mechanism of the universe in which their lot is cast. Now England is going to be represented at a point on this thin line, and therefore we must talk about an eclipse expedition in connection with this event; for while we write, the directors of the Peninsular and Oriental Company, who have ever shown the keenest anxiety to further the interests of science, are allowing the sacred bullion-room of the *Kaisar-i-Hind*, now getting up steam in the Royal Albert Docks, to be desecrated—as some will think, and they are welcome —by packing-cases of ungainly shape containing such instruments and combinations of brass and iron as have never been built before. The expedition in question, which has been equipped and manned by the Science and Art Department and the Royal Society combined, at the suggestion of the Solar Physics Committee appointed by the Government, of course is intended to occupy a position along that thin line to which reference has already been made, and the most easily accessible point is one on the Nile, about 100 miles north of Thebes, in lat. 26 deg. 32 N.; the most easily accessible, but not perhaps quite the best, for the reason that on the Nile the totality —that is, the period during which the moon entirely covers the sun—will only last some 72 seconds, whereas at Teheran there will be 104 seconds of darkness, which it is to be hoped the Russian astronomers will utilise. Seventy-two seconds! The time is not long, and when it is stated that the preparation of the new instrumental combinations and the investigation of the new methods to be employed have required three months' solid work and thought, many will ask whether the game is worth the candle. The following considerations will show that it was distinctly the duty of the men of science interested in these problems to endeavour to secure observations:—In the first place, it is a little discouraging to travel thousands of miles, and to go through all the preliminary work and anxiety connected with such an expedition, even if the eclipse is two or three minutes long, should the weather chances be 2 or 3 to 1 against success. On the Nile the weather chances—that is, the ordinary weather chances —are perfect, and there will be neither rain nor cloud. Secondly, the eclipse happens at the most critical time of the solar activity, thereby offering a most marked contrast to the last one observed in 1878. Then the sun was quite quiet. It was in a condition of almost unparalleled repose. Now, judging by what has happened, the sun should be in a condition of intense action, and from the recent rapid increase both of spots and prominences we know the prediction is being fulfilled. Thirdly, the remaining ten eclipses observable during the present century—for, thanks to the diligence of Mr. Hind and others, we know almost to a minute when and where total eclipses will be visible until the year 1900—are not conveniently situated for observation, as the following list will show:—Next year one occurs with a maximum totality of 6 min., but the course is almost entirely over the Pacific Ocean. In the Marquesas, however, a duration of totality of 2 min. 53 sec. may possibly be available. The next (1885) is accessible only in New Zealand, where the greatest totality will be almost 2 min. The longest eclipse, as before, falls on the Pacific. The eclipse of 1886 has the longest totality in the century, but this falls over the Atlantic. In Grenada the totality will last $3\frac{1}{4}$ min. On the African coast, south of Angola, the duration will be more than $4\frac{1}{2}$ min. The eclipse of 1887 will be best observed in Russia, and 50 miles north of Moscow the totality will have a duration $2\frac{1}{2}$ min. On Lake Baikal the totality will last 3 min. 38 sec. The eclipse of 1889 will have at Angola a duration of about $3\frac{1}{2}$ min., and at Barbadoes of about $1\frac{3}{4}$ min., its greatest duration being upon the East Atlantic. The next eclipse (1892) falls entirely on the South Pacific, and Antarctic Oceans, and must be lost, although the duration of totality extends to more than 4 min. On the whole, the most favourable eclipse for observation in the present century will be that of 1893, which enters the American continent near Coquimbo, where totality lasts nearly 3 min.; then, crossing Brazil, it leaves the land near Ciara, where the duration will last $3\frac{3}{4}$ min. Crossing the Atlantic, it will again reach land near Bathurst, with a totality lasting about 4 min., and, crossing Central Africa, will leave the land finally near Khartoum. The eclipse of 1894 will occur almost, if not entirely, over the sea or the inaccessible regions of Central Africa, but it may be total in the Seychelles. High latitudes are singled out for the path of the next eclipse (that of 1896), which, entering the Old World in Norway, passes across through Siberia to Japan. At Tana, in Finmark, a totality of about $1\frac{3}{4}$ min. may be observed. Hindostan will be the most favourable locality for observations of the eclipse of 1898, which will have a totality of a little more than 2 mins.

It will be seen from the above list that although doubtless attempts will be made to secure observations of some of these eclipses, yet that in no case are we likely to get such a grand harvest of facts as have been secured during the last twenty years, notably during the eclipses of 1868 in India, 1869 United States, 1870 Mediterranean, 1871 India, 1875 Siam, and 1878 United States again. This condition of things of course makes one hope that the coming seventy-two seconds will be utilised to their utmost, and in consequence of the warm co-operation of the Egyptian Government, which has been appealed to by our Foreign Office, a serious attack is contemplated; that is to say, in consequence of the local transport facilities afforded, large instruments, combining great solidity and fineness of adjustment, will replace the mountain artillery, so to speak, which alone can sometimes be employed. The something like thirty cases into which each separate part of the two equatorial stands and telescopes to be used, with their spectroscopes and cameras, have been separately packed for convenience of carriage, will, on disembarkation at Suez, be placed in a special van which, on arrival at Cairo, will be ferried over the Nile, and so on to Siut, the most southerly railway station in Egypt. Another instance may be given of the keen interest which the Egyptian Government is taking in the matter. The shorter the totality, of course the nearer the exact central line of the eclipse must the observing party be in order to secure the maximum of the calculated period of obscuration. Stone Pacha, chief of the staff, who is personally sparing no pains to make all

preliminary arrangements, and to secure the success of the observations, has detailed one of his officers, at present stationed in Upper Egypt, to check the latitudes of the French map where the eclipse track crosses the Nile. Indeed, he has done more than this, and here comes the dark side of the picture so far as the observers are concerned. The eclipse happens in the very midst of the Khamseen season—that is the period of fifty days during which Lower Egypt is apt to be swept by a hot, exhausting south-east wind, so dust-laden at times, that the sun is totally obscured. To escape the chances of this double eclipse, or at all events to minimise them, it will be necessary for the party to occupy high ground. Stone Pacha is, therefore, after consultation with our Consul-General in Egypt, prospecting for a camp and providing the necessary camp equipage, and although he himself will not, we believe, accompany the expedition, it is hoped that an officer of the Khedive's household, himself an adept in astronomy, which he has studied at both Paris and Washington, will accompany the expedition as guide, counsellor, and friend, to assist in making the necessary arrangements with the various local authorities. So much, then, by way of preliminary. Now, a word on the instruments to be employed on this occasion. The resources of modern science place many means of attack in the hands of the astronomer. To get an idea of the physics of the solar atmosphere—what it looks like—to study, so to speak, its circulatory system, to which such special attention has been recently directed by the bold hypothesis of Dr. Siemens—to investigate its extent, and to determine the luminosity of its various regions, we have the astronomical telescope, and, better even than this for some purposes, the photoheliograph, that is an instrument which enables us to obtain a photograph of all the sun's surroundings visible during the eclipse. To determine the chemical nature of the various regions, a question to which the keenest interest attaches at the present time, we have the spectroscope and the spectroscopic camera. By means of these instruments we can see what we cannot photograph, and photograph what we cannot see. In former eclipses, when the duration of totality has been longer, it has been possible to have different instruments mounted on different stands—there has been time to go from one to the other. But on this occasion such a course would be impossible. On one stand, therefore, we have four telescopes and two spectroscopes for eye observation. On another stand we have a photoheliograph and spectroscopic camera for photographic registration. In the observing telescope two spectroscopes are so arranged that a movement of the eye through two inches is all that is required to pass from the greatest spectroscopic dispersion (7 prisms of 60°) to the lowest (1 prism of 60°) which can be conveniently employed during an eclipse. In this way it is hoped that the spectrum of the brightest and the spectrum of almost the dimmest part of the sun's atmosphere can be observed, and for the first time in the history of eclipse observation, comparisons will be made with the solar spectrum itself, as a solar photograph taken before totality will be used as a scale. Much is hoped in the way of the photographic record, for since the last eclipse, the science of photography, following step by step the new views of molecular grouping suggested by the spectroscope, has provided us with silver salts, identical in chemical composition, but so different physically that the red part of the solar spectrum can now be recorded as satisfactorily as the blue part of the spectrum has ever been. Nor is this all. The rapidity with which an image can be impressed upon a sensitised plate has been enormously increased, so that if all goes well, seconds now take the place of minutes, and more can be recorded in five seconds now than was possible in five minutes twenty years ago.

We have no space in the present article to refer more precisely to the exact work which it is proposed to undertake, but this much may be said, that in eclipse, as in all other kinds of scientific observation, each attempt made to secure facts, instead of exhausting, increases the number of points of interest to be investigated, and now-a-days we not only get this principle at work from eclipse to eclipse, but daily work in our laboratories and physical observatories suggests questions which can only be solved at such times. Hence eclipse observations are getting more and more connected with terrestrial chemistry and terrestrial physics by this intermingling of laboratory and eclipse work, and hence also the area of general interest will be increased as time goes on.

In conclusion, we may state that the Government expedition will consist of Mr. Norman Lockyer, F.R.S., and Dr. Schuster, F.R.S., with their assistants, Messrs. Lawrance and Woods. Capt. Abney, who was at first detailed for the duty, is prevented by ill-health from joining the expedition, but the photographic preparations have been made under his supervision. It may be added that Mr. William Black and Mr. J. Y. Buchanan, late of H.M.S. *Challenger*, will accompany the expedition, and it is hoped that Prof. Tacchini may join it at Cairo. The *Kaisar-i-Hind* leaves Gravesend at 12.30 this day.

THE EDINBURGH FISHERIES EXHIBITION

THE International Fisheries Exhibition, which opened at Edinburgh on the 12th ult., and to which reference has been already made in the columns of NATURE, is likely to prove a complete success—not only commercially, but also as an exhibition of much that is interesting in the natural history of our most valuable marine animals.

The apparatus of capture takes up a large space inthe Waverley Market Hall, but no particular novelty in the way of fish-traps is shown; no artificial bait that would supersede the whelk or the mussel in the taking of cod has apparently been yet invented, although much required. Several models of improved rigs for fishing-boats are shown, but no improvement has apparently been effected on the ponderous beam trawl, which is much complained of as a cumbrous instrument of fish capture. The exhibition is rich in specimens of stuffed fish contributed by various bodies of London anglers—but why not label them? It is not given to every visitor to a fishery exposition to know a jack from a perch. Some of the late Mr. Buckland's finely modelled and correctly coloured fishes have been sent from Kensington—notably a model of a salmon captured in the Tay, which weighed, when taken, 72 lbs. Considering the importance of the salmon to Scotland as a rent-yielding fish, we had expected to find in the exhibition a methodical display of the progress of that mysterious disease which has of late overtaken that fish; but, beyond a drawing of an afflicted salmon, we saw no other indication of the calamity. The display of oysters in progress of growth from the *spat* to the stage of reproduction, although not large, is exceedingly interesting. We pass over, in the meantime, the merely commercial exhibits, of which of course there are many, and shall only say of the piscicultural exhibition, that it merits at our hands a much fuller notice than we have room to bestow on it at present. A large number of maps, charts, books, and engravings, bearing on the natural history of our food-fishes and the economy of the fisheries, may be seen and consulted in the exhibition hall, whilst the illustrations of river pollution and purification attract a large degree of attention. Despite the deficiencies at which we have hinted, the exhibition is a valuable one, and, although not all at once, may lead to some new departures in the art of fishing, which may tend to augment in a striking way the national commissariat.

Among the exhibits which have attracted special attention are those sent by Mr. Oscar Dickson, of Gothen-

burg, and the Swedish collection generally, and of these we give some notice below. They are exceedingly varied and, in addition to being of great scientific value, are also interesting to persons who have a monetary interest in our fisheries. Mr. Dickson's name is already familiar to the readers of NATURE, in connection with his well-timed support of various Arctic expeditions fitted out from Sweden, and along with his exhibit, or as we may say forming part of it, are two cabinets of preparations of marine animals brought home in the *Vega*, embracing spoils of the sea, obtained by Baron Nordenskjöld in his famous voyage of 1878-80. It is much to be regretted that a catalogue of this exhibit has not been prepared, or at any rate cannot yet be obtained, but a glance at the jars is almost sufficient to show us that there are numerous "finds" of great interest to zoologists. The collections made of worms and crustaceans, of crinoids, sponges, and holothuridæ are exceeding varied, and have been preserved with much care; they evince the activity of all concerned, particularly Dr. Julius Stuxberg, who was "lord of the dredge" in both of Nordenskjöld's Yenisci voyages. The work done with the dredge has already been chronicled in the account given of the voyage of the *Vega*, and it is to be regretted that, from the want of a catalogue, we are unable to do more at present than make this general reference to the collection, which shows us how rich in varied life are the depths of the sea in the high latitudes visited by the professor. A portion of the skeleton of the famous Steller's sea-cow (*Rhytina stelleri*) excites much attention. This animal, there can be little doubt, is now extinct; but when living, it must have been of large proportions, and not unlike a gigantic seal; it would probably be from 25 to 38 feet in length, and weigh 75 cwt., more or less. These remains are of signal importance, proving, as they do, what has been over and over again denied—the existence of a marine mammal of great size and power, herds of which used to browse on the fields of sea-weed.

As may be supposed, "the Swedish Collection" is rich in preparations of the herring: there are over seventy specimens of that fish (*Clupea harengus*), exhibiting its growth from the ova to its most complete stage—that of reproduction. The growth of the sprat (*C. sprattus*) is likewise illustrated in a series of twenty-four preparations, which are of singular interest, so many persons believing that the latter fish is simply a young herring. It is certainly a curious circumstance that the two fish are frequently caught in the same nets, but upon being handled a difference is at once felt, although when taken, both fish are of the same size. The sprat can be at once distinguished from the young herring by means of its strongly serrated abdomen, and when closely examined, it presents several other differences alike of colour and form. A few preparations to show the growth of the pilchard (*C. pilchardus*) are also contained in the Swedish collection. Although the fisheries of Sweden are not of so much value as those of some other countries, great pains have been taken by those in charge of them to teach their fishermen how to make the most of what they have access to—hence the careful preparations of the herring. On the Cattegat an important fishery has been organised, but taken as a whole the total value of the Swedish fisheries is not more than 400,000*l*. per annum. But the Swedish fishermen, not content with the produce of their own waters, venture to the west coast of Norway and the west coast of Jutland, and find it to their interest to do so. Their chief fishing industry when at home, excepting their labours on the coast, consists in capturing the small Baltic herring, which they accomplish by means of seine nets, of good material, and very well made. The industry of herring catching, according to Mr. Oscar Dickson, is of great antiquity in Sweden, and the product of the shoals at particular times, has been of far greater value than the figures we have quoted above serve to indicate. From time to time the fishermen have been cheered by the advent of great bodies of herrings, and at one period, the take in some years, amounted to between two and three million barrels of eight cubic feet each per annum. The catch of herrings last year, the statistics of which have not yet been prepared, is said to have been "positively enormous." It is somewhat remarkable, however, that the figures of the Swedish herring fishery, which were circulated at the Berlin Exhibition of 1880, on the authority of Dr. Lundberg, do not correspond with those for which we are indebted to Mr. Oscar Dickson; according to Lundberg the herring-fisheries of Sweden are of the value of 5,000,000 *marks* annually, but the "millions" of barrels indicated by Mr. Oscar Dickson mean "millions" of *pounds* (not *shillings*) sterling. It is to be hoped this discrepancy of figures will be explained.

Besides these herring exhibits, there is much that is worthy of notice in the Swedish collection. There is, for instance, a display of the eggs of birds which prey on fish. This selection is from the prolific store of Mr. Ramberg, whose collection at Gothenburg is of world-wide celebrity. Some of the eggs which are shown are those of very rare birds. The development and growth of one of our flat fishes (*Rhombus lævis*) is exemplified in all stages of growth, some of which are singular, as, for instance, the changing of the eye in the flounder from one side of its head to the other. We hope Mr. Oscar Dickson's contributions and those from the Gothenburg Museum will be shown in London next year, and that Dr. A. W. Malm will again be in charge of the whole of the Swedish collection, which would require a much larger amount of space for its description than we have at present to bestow.

One of the most interesting of the exhibits shown in the Fisheries Exhibition is Sir John Graham Dalzell's smooth sea-anemone (*Actinia mesembryanthemum*), which is familiarly known as "Granny." It was taken from a rock pool at North Berwick, on the Firth of Forth, so long ago as August, 1828, and was then placed in the glass jar in which it is now exhibited. At that time it was thought it might be seven or eight years old, and its age at present may be over sixty years. During a period of twenty years "Granny" produced 334 young ones. In 1851, after the death of Sir John, who, according to the article "Aquarium," in the "Encyclopædia Britannica," was a keen student of marine animals, several of which could always be seen at his house in a humble kind of aquarium, this anemone was placed in the possession of the late Prof. John Fleming, and was carefully tended by him so long as he lived. Shortly before the death of the Professor, which took place in November, 1857, "Granny" unexpectedly gave birth, during a single night, to 240 living young actiniæ. Dr. James McBain, R.N., who took a warm interest in zoological affairs, was the next custodian of the smooth sea-anemone, which was presented to him by the widow of Prof. Fleming; it remained in his custody until a few days before his death in March, 1879, when he presented it for safe keeping to Mr. John Sadler, curator of the Royal Botanic Gardens in Edinburgh. In the glass jar, along with "Granny" three out of seven young ones are shown, born on February 18 last. As may be supposed, with such an interesting biographical record, Sir John Graham Dalzell's smooth sea-anemone is a decided feature among the "exhibits." Sir John was the author of "Rare and Remarkable Animals of Scotland," as well as numerous other works now forgotten.

NOTES

SIR H. COLE, K.C.B., late director of the South Kensington Museum and Inspector-General of the Science and Art Department, died on Tuesday night at his residence, Philbeach Gardens,

Earl's Court. Sir Henry was in his usual health until Monday last, when he visited a photographer's and sat for his portrait. On returning home, he complained of feeling unwell, and gradually became worse. The cause of death is stated to be disease of the heart.

WE have received a most remarkable communication in the form of a pamphlet from the late Professor of Physics and Chemistry at the Royal Military Academy, which, were it not for his high scientific position and extended experience, we should hesitate to allude to. The grievance mostly complained of is the want of discipline existing amongst the cadets, so much so that the instruction in the above-mentioned very important subjects could only be carried on in an imperfect manner detrimental to the service. That such a state of affairs has or does exist in an important public department like the Royal Military Academy is a very serious matter. The pamphlet, for which Prof. Bloxam is answerable, exposes, if correct, a state of things that certainly should not exist in any educational establishment, and more especially not in one of the importance of this school for the future officers of the army. The following, from one of the letters contained in the pamphlet, certainly exhibits, if correct, a very undesirable state of affairs. "During the last ten years, I have pointed out to successive Governors, that the character of the classes was deteriorating, and I have now to state, with profound regret, that the conduct of the majority, when they first come under my instruction, and of a considerable proportion up to the end of their curriculum, is that of boys in an ordinary boarding-school with a very low standard of morals and discipline; so that the position which was formerly held by Professors Faraday and Abel has now become that of an usher, and such services as I am competent to render as a teacher of science are in a great measure lost to the Academy, although a knowledge of chemistry and physics has become more than ever necessary to the Scientific Corps."

THE honorary degree of LL.D. has been conferred upon Mr. G. J. Romanes, F.R.S., by the University of Aberdeen.

M. HENRY GIFFARD, the eminent French engineer, the inventor of the injector known by his name, of captive balloons, and of the experiments with directing steam balloons, has died after a protracted illness, at his residence at Paris, at the age of fifty-seven. He was unmarried, and has left his large fortune, amounting to several millions of francs, to the French Government to be devoted to the promotion of scientific research.

AT the Royal Institution the probable arrangements for the Friday evening meetings after Easter are as follows:—April 21: Prof. Dewar, Experimental Researches of Henri Ste. Claire Deville, Hon. M.R.I.; April 28: Prof. Abel, Some Dangerous Properties of Dusts; May 5: Prof. R. Grant, The Proper Motions of the Stars; May 12: A. G. Vernon Harcourt, The Relative Value of Different Modes of Lighting; May 19: Sir Frederick Bramwell; May 26: Sir Henry S. Maine, Sacred Laws of the Hindus; June 2: H. H. Statham, The Intellectual Basis of Music; June 9: Prof. Burdon Sanderson, The Excitability of Plants.

WITH the exception of Mr. Samuelson, M.P., and Mr. Slagg, M.P., the Royal Commissioners on Technical Education, viz., Mr. Woodall, M.P., Professor Roscoe, Mr. P. Magnus, Mr. Swire Smith, and the secretary, will leave England on Friday for a tour of several weeks in Switzerland and Germany, beginning at Alsace. Mr. Woodall, who will return earlier than the other members of the party, proposes also to visit the famous potteries of Saarguemines. In the course of their tour the commissioners will visit a number of works, technical schools, &c., in order to be able to include in their next report the result of their observations as to the influence of scientific and technical education upon industrial pursuits and foreign manufactures.

MR. E. W. WHITE, F.Z.S., of Buenos Ayres, who was present at the inauguration, on March 15, of the Continental Exhibition, held in the outskirts of that city, sends us a short notice of it. The building of wood and zinc, painted of a sombre colour, and a pretty close copy in miniature of that of the Paris Exhibition, covers about eight acres of ground, occupying the site of the Plaza Once. The present Exhibition is the result of the unceasing efforts of the Industrial Society of Buenos Ayres. To foster South American, and especially native, production, and stimulate their industries, were the special objects of the Committee, so that Europe was debarred as an exhibitor, in all but the single item of machinery. This restriction put upon exhibits without the limits of the continent of South America seems to Mr. White a suicidal policy, as it is only by comparison with the superior that the inferior has a chance of improvement. "What immediately strikes the observer on passing through the galleries is the wonderful profusion of native products, especially from the provinces, but the paucity of purely native industries; for although the city and province of Buenos Ayres make a good show in leather work, furniture, and carved woodwork, glass, inks, jewellery, millinery, carriages, typography, lithography, photography, liquors, beers, biscuits, metal castings, mosaic and tilework, &c., such is chiefly due to the intelligent foreign workmen resident in her midst, making use to a very great extent of foreign material; whilst, on the other hand, ores, marbles, wines, cereals, wool, silk, hides, leather, tans, woods, lignite, medicinal herbs, rice, tobacco, sugar, cotton, fruits, manures, dried and potted meats, fossils, &c., of the interior parts of the country astonish and indicate a future wealth which is boundless. Agricultural machinery is well represented, and forms a very interesting feature of the Exhibition; here England maintains her supremacy, owing to the intelligence and activity of her agents. Far otherwise, however, is it in other classes of machinery, such as that adapted to sugar manufacture, in which France, with inferior resources, rules as sole monarch; the fact is the moral of the bundle of faggots is lost upon our countrymen, who are always disunited, always late, and never learn, never forget. The inauguration took place in the midst of great splendour. Dr. Avellaneda, the ex-President of the Republic, and the honorary president of the Exhibition Committee, delivered the inaugural address, which was a brilliant piece of oratory, to which General Roca, the President of the Republic, surrounded by the whole diplomatic corps, foreign and native, replied in a very effective speech, declaring the Exhibition open."

WE are glad to welcome the *New Zealand Journal of Science*, the first number of which for February, has come to hand (Duneden, Wilkie, and Co.). It seems to have been started in a proper spirit, and we trust it will continue as it has begun, to devote its pages to science in New Zealand, and to form a means of intercommunication between workers in science there. Among the articles in this number are the following:—"What is an Earthquake?" by Prof. F. W. Hutton; "A Visit to the Weka Pass Rock Paintings," by Mr. W. M. Maskell; "On the Preservation of Invertebrata," by Prof. T. J. Parker; "On a Common New Zealand Pycnogonid;" "The New Zealand Micro-Lepidoptera;" with general notes, meetings of societies, and correspondence.

WE have received from Messrs. Trübner and Co. a handsome and richly illustrated quarto, "The Horse in Motion, as shown by Instantaneous Photography, with a Study in Animal Mechanics, founded on Anatomy and the Revelations of the Camera, in which is demonstrated the Theory of Quadrupedal Motion," by J. D. B. Stillman, A.M., M.D. The investigations are

executed and published under the auspices of Mr. Leland Stanford, of Palo Alto Farm, California. We hope shortly to notice this work at some length, and meanwhile make the following extract from Mr. Leland Stanford's preface, which shows the exact part taken by each of those concerned in the investigation:—"I have for a long time entertained the opinion that the accepted theory of the relative positions of the feet of horses in rapid motion was erroneous. I also believed that the camera could be utilised to demonstrate that fact, and, by instantaneous pictures, show the actual position of the limbs at each instant of the stride. Under this conviction I employed Mr. Muybridge, a very skilful photographer, to institute a series of experiments to that end. . . . When these experiments were made, it was not contemplated to publish the results; but the facts revealed seemed so important, that I determined to have a careful analysis made of them. For this purpose it was necessary to review the whole subject of the locomotive machinery of the horse. I employed Dr. J. D. B. Stillman, whom I believed to be capable of the undertaking. The result has been, that much instructive information on the mechanism of the horse has been revealed, which is believed to be new, and of sufficient importance to be preserved and published."

We notice an interesting innovation introduced into the secondary schools at Wilna, Russia, namely, a popular medical course for the scholars of the higher class. Nearly all scholars have expressed the wish to follow these lectures, which contain general notions of hygiene and those necessary for giving medical assistance in simpler diseases, and the results obtained during the first year are said to be very satisfactory.

According to the *Mémorial Diplomatique*, the Congress of Electricians for determining the length of the column of mercury equivalent to the theoretical ohm, the advisability of establishing a system of tele-meteorology, and a system of observations for the electricity of the air, will meet on May 1 at Paris. Almost all the foreign governments, including the British, have appointed their delegates. The names of two only are wanting.

The Ethnological Museum of the Trocadero, Paris, has been inaugurated by a visit of the delegates of learned societies and a lecture by Dr. Hamy, one of the directors of the new establishment.

The meeting of the delegates of the learned societies of France took place at the Sorbonne on April 11, under the presidency of M. Leopold Delisle, member of the Institute belonging to the Commission of History, Archæology, and Philology. The Commission of Sciences was presided over by M. Milne-Edwards; M. Catalan was nominated president of the section of mathematics, M. Filhol of physico-chemical sciences, and M. Coteau of natural history. The sittings were not so numerous as in former years, and the communications were almost devoid of any real interest. The concluding sitting took place on April 15, M. Ferry, Minister of Public Instruction, being in the chair. He delivered a speech purporting to justify some changes in the general organisation of the Congress. They do not appear to have been beneficial to the institution, if it is possible to judge by the results of the present session, which has been the most barren of the whole series from 1863, when it was created by the government of Napoleon III., owing to the exertions of Leverrier.

The fourth general meeting of the delegates of the French departmental meteorological commissions met on April 13, under the presidency of M. J. Ferry, Minister of Public Instruction. The report on the working of the Central Bureau was presented by M. Hervé-Mangon, president of the Council of that institution. The Central Bureau receives daily ninety-seven telegrams from foreign parts, and fifty-two from France. These documents are utilised for drawing five maps in the morning and three in the evening, representing isobaric and isothermic curves, and variations of these elements from the preceding day, the force and direction of winds, rain, and storms. The warnings are sent by telegraph to eight agricultural regions and four maritime districts. The report states that these previsions were justified eighty-two times in one hundred. M. Hervé-Mangon proposes to extend the system of elegraphic connection to the Azores and Cape de Verde Islands in the south, United States in the west, and Ireland in the north. M. Hervé-Mangon reviewed the progress of high-level observatories. The observatory on the top of Pic du-Midi has just been fitted up at an altitude of 2877 metres, about twice the height of the Puy-de-Dome. General Nansouty's observations are wired every day, but this hardy observer and his followers having been blocked up by snow he was unable to attend the meeting. Before the end of the year a new mountain observatory will be completely established on Mount Aignal. The number of pluviometrical stations in the whole of France is 1561; the system is complete only in eighteen departments, in sixty-nine deficient, in ten *nil*. For the observation of thunderstorm phenomena forty-six departments send regular reports. Some details were also given on the expedition that France will send to the Antarctic regions. The station will be located somewhere on the islands situated to the south of Magellan Straits, very likely Orange Bay in Terra-del-Fuego, or Saint Martin Creek in Hermite Island.

We learn from the *Izvestia* of the Russian Geographical Society that N. W. Kaulbars, well known by his travels in Turkestan, has just published a very interesting work, "Notes on Montenegro," which contains under this modest title a very good description of that country. He knows the country from his own experience, having visited it three times as Russian commissioner, and having travelled throughout the Principality. The geographical and physical description of Montenegro is very complete.

Mr. C. Wolcott Brooks sends us an abstract of a paper which he read on March 21 at the Californian Academy of Sciences, giving the temperatures of the ground in the Forman shaft of the Comstock lode, at Virginia City, Nevada, taken by Charles Forman, superintendent, and forwarded by him for presentation to the Academy. They are taken from the surface to the depth of 2300 feet, as ascertained by drilling holes not less than 3 feet deep into the rock, and inserting into the hole a Negretti and Zambra slow acting thermometer, of the pattern adopted by the Underground Temperature Committee of the British Association, and standardised at Kew. These holes were closed with clay, and the thermometers were left in for twelve hours, not less than three holes being tried at each point. The following are the depths in feet, and temperatures in degrees Fahrenheit:—

Feet.	Deg.	Feet.	Deg.
100	$50\frac{1}{2}$	1300	$91\frac{1}{2}$
200	55	1400	$96\frac{1}{2}$
300	62	1500	101
400	60	1600	103
500	68	1700	$104\frac{1}{2}$
600	$71\frac{1}{2}$	1800	$105\frac{1}{2}$
700	$74\frac{3}{4}$	1900	106
800	$76\frac{1}{4}$	2000	111
900	78	2100	$119\frac{1}{2}$
1000	$81\frac{1}{2}$	2200	116
1100	84	2300	121
1200	$89\frac{1}{4}$		

Messrs. Blackie and Sons have issued the second volume of the new edition of their "Imperial Dictionary," the first volume of which we noticed some time ago. It extends from *Dep* to *Kyt*, and is in all respects up to the standard of the previous volume.

MESSRS. JARROLD AND SONS have published a "Handbook to the Rivers and Broads of Norfolk and Suffolk," by Mr. G. Christopher Davies, who seems to be thoroughly acquainted with every winding and nook of these curious features of East Anglian scenery. It seems a really charming and easily accessible place for a quiet and refreshing holiday, gives ample scope for the collecting naturalist and the fisher who loves a well-filled basket.

FROM the *Report* of the Rugby School Natural History Society for 1881, we see that the work has been fairly sustained. The *Report* contains few papers by the members of the Society themselves, considerable space being given to an abstract of four instructive lectures on the Natural History of Islands, by Mr. A. R. Wallace. Appended to Mr. Seabroke's usual observatory report, is a Syllabus of work with the instruments in the Temple Observatory, which shows that very thorough instruction in practical astronomical work is available for the Rugby boys.

THE scarcity of water is excessive in France and Germany; the level of the Seine has never been so low since 1734. The quantity of rain which fell this winter has not reached half the usual quantity. The engineers of the City of Paris and the Government are trying to find protection against such a scarcity, which will turn to a calamity if rainy weather does not set in shortly.

IN February of last year an account was given in this journal of Baeyer's method for preparing artificial indigo (NATURE, vol. xxiii. p. 390). The fifth step in the process, as there described, consisted in the preparation of *orthonitrophenylpropiolic acid*: in a patent recently obtained by the "Badische Anilin und Sodafabrik," bye-products obtained from this acid are employed as sources of indigo. By the action of alkaline-reducing agents, *e.g.* ammonium sulphide, on the ethyl salt of this acid, *ethylic indogenate* is obtained; thus, $C_8H_4 . NO_2(CO_2 . C_2H_5) + 2H_2 = C_8H_6NO(CO_2 . C_2H_5) + H_2O$. *Indogenic acid* (melting at 122° to 123°) is obtained by saponifying this ethylic salt; the acid easily gives off carbonic anhydride, either by boiling in aqueous solutions or by heating to its melting-point, with the production of *indogen*, C_8H_7NO, an oily liquid, showing yellow-green fluorescence. Any of these substances—ethylic indogenate, indogenic acid, or indogen—readily yields indigo blue by the action of dilute acids or alkalies, when freely exposed to the air, without heating.

THE recent study of the Rhone glacier by M. Gosset is probably the most detailed and exact that has ever been made of a glacier. According to Prof. Rutimeyer (who has recently written on the results of these researches) a precise topographical knowledge of the glacier is supplied; and the scale of representation (1 : 5000) allows of following all the details of form. There are also exact data as to the glacier's movements. Four rows of stones of different colours were placed, in 1874, on its surface, and their position has been precisely noted from time to time. These observations prove that the glacier advances much more rapidly in the upper part (600 to 680 m. since 1874) than near the extremity, where the progress has only been 150 m. below the cascade of ice; also that the ablation, *nil* in the higher parts, is very great in the lower; and that the difference in the progress of the central and the lateral parts of the glacier is much greater in the first part.

M. MONTIGNY published, a short time ago, some interesting observations on the effects of lightning on trees placed near a telegraph wire. A more extended examination of the road from Rochefort to Dinant has enabled him to mature his conclusions, and he now affirms (*Bull. Belg. Akad.*, 1) that "in the section of road beyond Rochefort, nine kilometres in extent, where one notices poplars that have been struck by lightning near a telegraph wire, the fulminant fluid has scarcely produced its effects, except in places where the provocative action of the wire is favoured by the influence exerted on it by a considerable group of lofty trees; this action is especially favoured in places where the road traverses woods on an elevation, but the differences of height seem to have less powerful influence than the surrounding and neighbourhood of wood." This conclusion agrees with what Arago observed as to the objects and places which lightning strikes by preference.

THE additions to the Zoological Society's Gardens during the past week include a Malbrouck Monkey (*Cercopithecus cynosurus*) from East Africa, presented by Mr. Robert Mills; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. T. W. Gourlay; a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr. E. W. Hills; a Black-backed Jackal (*Canis mesomelas*) from South Africa, presented by Capt. E. Jones; a Canada Goose (*Bernicla canadensis*) from North America, presented by Mr. George Edson; a Saker Falcon (*Falco sacer* ♂), captured in the Red Sea, presented by Mr. Battersby; a Chimpanzee (*Anthropopithecus troglodytes* ♀), an Angolan Vulture (*Gypohierax angolensis*), a Mueller's Parrakeet (*Tanygnathus muelleri*), a Ludio Monkey (*Cercopithecus ludio* ♂), a Blackish Sternothere (*Sternothærus subniger*) from West Africa, an Opossum (*Didelphys*, sp. inc.), a Kinkajou (*Cercoleptes caudivolvulus*), a Great-billed Rhea (*Rhea macrorhyncha*) from South America, four Meyer's Parrots (*Pœocephalus meyeri*) from East Africa, a Magellanic Goose (*Bernicla magellanica*) from Patagonia, a Brazilian Tree Porcupine (*Synetheres prehensilis*) from Brazil, a Western Black Cockatoo (*Calyptorhynchus naso* ♂) from Western Australia, two Indian River Snakes (*Tropidonotus quincunciatus*), an Indian Cobra (*Naia tripudians*) from India, purchased; a Crested Screamer (*Chauna chavaria*) from South America, received on approval; two Golden-headed Parrakeets (*Brotogerys tui*) from South America, received in exchange; three Chilian Pintails (*Dafila spinicauda*), hatched in the Gardens.

OUR ASTRONOMICAL COLUMN

COMET 1882 *a*.—Observations by Prof. Tacchini at the Observatory of the Collegio Romano, Rome, on April 6, gave the following place of this comet:—

	M.T. at Rome. h. m. s.	R.A. h. m. s.	Decl. ° ′ ″
April 6 at	14 38 7	18 29 33·62	+44 54 34·9

From this position, which was kindly communicated by Prof. Tacchini, and those obtained at Harvard College, U.S., on March 19, and at Vienna on March 28, the following elements result:—

Perihelion passage 1882, June 9·96974 G.M.T.

	° ′ ″	
Longitude of perihelion	54 25 17·2	From Ap. Eq. April 0.
„ ascending node ...	204 37 42·1	
Inclination	73 35 39·4	
Log. perihelion distance	8·748238	

Motion—direct.

The co-ordinate constants to this parabola are (App. Eq. May 0):—

$$x = r\,[9·96219] \sin (v + 127°\ 10'·3)$$
$$y = r\,[9·86101] \sin (v + 61\ 33·8)$$
$$z = r\,[9·90055] \sin (v + 197\ 45·4).$$

Hence with the X, Y, Z of the *Nautical Almanac* the following positions are found:—

At Greenwich midnight

	R.A. h. m. s.	Decl. ° ′	Log. distance from Earth.	Sun.
April 20	19 15 41	+57 27·7	0·0528	0·1610
22	19 25 49	59 31·0	0·0414	0·1488
24	19 37 33	61 36·7	0·0303	0·1362
26	19 51 22	63 43·7	0·0196	0·1230
28	20 7 51	65 50·4	0·0093	0·1091
30	20 27 49	+67 54·8	9·9995	0·0946

Mr. J. T. Barber of Spondon, Derby, informs us that on April 6, the night of the above observation at the Collegio Romano, he considered that the total impression given by the comet's light was about equal to that of a star of the seventh magnitude. If we take the theoretical intensity of light (represented by the reciprocal of the product of the squares of the distances of the comet from the earth and sun) as *unity*, we find the intensity on the following dates :—

May 12 ...	7·1	May 20 ...	11·8	May 28	24·2
16 ...	9·1	24 ...	16·0	June 10 (perihelion)	1590·0

The Solar Eclipse of May 16.—The *Nautical Almanac* gives the following particulars of this phenomenon, which is seen as a small partial eclipse in these islands :—

	Begins.	Greatest phase.	Ends.	Magnitude (sun's diameter=1).	Angle from N. point of first contact. *Direct.*
	h. m.	h. m.	h. m.		
Greenwich	18 10·5	18 46·0	19 23·0	0·186	158
Cambridge	18 13·2	18 47·7	19 23·7	0·175	159
Oxford	18 7·2	18 41·2	19 16·7	0·173	160
Liverpool	18 6·2	18 36·7	19 8·4	0·139	163
Edinburgh	18 13·2	18 40·2	19 8·1	0·105	167
Dublin	17 55·2	18 22·9	18 51·5	0·116	166

If we apply the Littrön-Woolhouse method of distributing the times approximately over this country we have the following equations :—

G.M.T. of	h. m.
Beginning	18 6·12 + [0·4696] L − [9·2403] M.
Greatest phase	18 43·58 + [0·2142] L + [8·5528] M.
Ending	19 22·58 + [9·4197] L + [9·4134] M.

The magnitude is given by 0·205 − [8·115] L + [7·250] M.

Here the latitude of the place for which the Greenwich times are required is put $= 50° + L$ (and expressed in degrees and decimals), and M is the longitude from Greenwich, taken positively towards the east, and expressed in minutes and decimals of time.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

Oxford.—Prof. Odling will conclude this term his course on the Atomic Theory; Mr. Fisher will lecture on Inorganic Chemistry; and Mr. F. J. Brown will form a class for practical instruction in organic chemistry.

Prof. Lawson will lecture at the Botanic Gardens on the General Morphology of Plants, and will continue his course on the Elements of Systematic Botany.

Mr. Yule will give a course of demonstrations at the Magdalen College Laboratory, on the Physiology of the Nervous System.

A Postmastership in Physical Science is offered by Merton College in June. The examination will be held in common with Magdalen and Jesus Colleges. The Postmastership is of the annual value of 80*l.*, and is tenable for five years from election, provided that the holder does not accept or retain any appointment incompatible with the pursuance of the full course of University studies. After two years' residence the College may raise, by a sum not exceeding 20*l.* per annum, the Postmastership of such Postmasters as shall be recommended by the Tutors for their character, industry, and ability.

Candidates for the Postmastership, if members of the University, must not have exceeded six terms of University standing, but there is no limit of age.

Mr. J. Perry, M.E., has been elected to the Chair of Mechanical Engineering at the City and Guilds Technical College, Finsbury, at the open election this week.

SOCIETIES AND ACADEMIES

London

Royal Society, March 30.—"On the Movement of Gas in 'Vacuum Discharges.'" By William Spottiswoode, F.R.S., and J. Fletcher Moulton, F.R.S.

In the preparation of tubes for our experiments, it was often noticed, that after the exhaustion had been carried to a certain degree, the passage of a strong current had the effect of increasing the pressure. This appeared to be due to an expulsion of gas from the terminals themselves by the passage of the discharge. And accordingly the use of such currents from time to time during the process of exhaustion was adopted for making the vacuum more perfect and more permanent than otherwise would have been the case. On the other hand, it was also noticed, that after the tube had been taken off the pump and sealed in the usual way, the passage of a strong current had in some instances the effect of decreasing the pressure. We thus met with two effects, apparently due to the same cause, but diametrically opposite in character.

Matters remained in this rather confused state, until we observed, with more care than before, a tube of which the exhaustion was near the phosphorescent state, and of which both terminals were metallic cones, and consequently presented large surfaces for any action which might take place upon them.

In what may be considered to have been its normal condition, this tube showed three or four large white striæ with a dark space of considerable size round the negative terminal. On passing the discharge through the tube for some minutes, the dark space increased, the striæ became fewer and feebler in illumination, the green phosphorescence began to show itself, and the discharge showed the usual signs of reduced pressure. On suddenly reversing the current, the striæ became again more numerous and more brightly illuminated, precisely as they would be by an increase of pressure, while the other features of the discharge in a great measure resumed their original character.

The most probable explanation of these phenomena appears to be this, that the effect of the discharge is actually to alter the pressure in the tube, not by any modification in the chemical composition of the gas, but simply by driving occluded gas out of one terminal, and by drawing it in, or occluding it, at the other. On reversing the discharge, the operation is reversed, and the occluded contents of one terminal are thrown along the tube to be occluded at the other. This view of the mechanism whereby the observed phenomena are produced is supported by the absence of these appearances when the terminals are comparatively small and the pressure is such that the occluded contents of the metallic mass forming one terminal would form only a small fraction of the total mass of gas in the tube; for in that case the pressure, and consequently the appearance of the discharge, would be affected only in an inappreciable degree by the injection of the contents of the terminal. It should also be added that, when the terminals are of unequal size, the effects are unequal, as might have been expected.

The phenomena in question appears to have so important a bearing on the mechanism of the discharge itself that it becomes a question of great interest to determine whether the missing gas is to be found in either of the terminals; and, if so, whether the ejection takes place at the positive, and the occlusion at the negative terminal, or *vice versâ*. For this purpose, I have devised a tube with three terminals, but have not yet had time to complete its construction or to make the experiment.

Zoological Society, April 4.—Prof. W. H. Flower, LL.D., F.R.S., president, in the chair.—Mr. Sclater exhibited and made remarks on an example of a rare Flycatcher (*Cyanomyias cœlestis*) from the Philippines, which had been sent to England for determination by Dr. Moesch of Zurich.—Mr. Sclater also exhibited and made remarks on two specimens of the Subcylindrical Hornbill (*Buceros subcylindricus*), which had been formerly living in the Society's Gardens.—Dr. A. Günther read the description of a new species of freshwater Turtle from Siam, a specimen of which had been recently acquired by the British Museum. The author proposed to name it *Geoemyda impressa*, from the peculiar shape of the principal upper plates, which are not merely flattened, but distinctly concave.—Mr. W. A. Forbes read a paper on the structure of the convoluted trachea of two species of Manucode (*Manucodia atra* and *Phonygama gouldi*), and added remarks on similar conformations in the tracheæ of other birds.—Mr. J. E. Harting read a paper on the eggs of three species of wading-birds which had been obtained by the Rev. W. Deans Cowan in the neighbourhood of Fianarantosa in the Betsileo country, Madagascar. The species to which these eggs belonged were *Glareola ocularis*, *Ægialitis geoffroyi*, and *Gallinago macrodactyla*. Much interest attached to these eggs, as not having been previously described.—A communication was read from Mr. E. P. Ramsay, C.M.Z.S., containing the description of a supposed new species of *Tephras*, an example of which had been obtained by the late Mr. S. White while collecting at the Aru Islands. The author proposed to name it *Tephras whitei*, after its discoverer.

Chemical Society, April 6.—Dr. Gilbert, president, in the chair.—The following papers were read:—On the action of acetyl chloride on fumaric acid, by W. H. Perkin. The author criticises the statements of Auschütz, and considers that the views of that chemist as to the above reaction are unsatisfactory. Probably the acetyl chloride removes a molecule of water from the fumaric acid yielding maleic anhydride.—Some arguments in favour of the prism formula of benzene, by U. K. Dutt.—On a convenient apparatus for the liquefaction of ammonia, by J. Emerson Reynolds. This essentially consists of a stout iron U-tube, into one leg of which is cemented a stout glass tube, containing dry ammonia gas; the other leg of the U, which is closed by an iron cap, contains some strong solution of ammonia. The intermediate space is filled with mercury. On heating the solution, pressure is produced, sufficient to liquefy the gas.—On the transformation of urea into cyanamide, by H. J. H. Fenton. On gently heating urea with metallic sodium, a violent reaction ensues; hydrogen is evolved, and a body, having the composition and all the properties of cyanamide, is formed.—On the action of haloid acids upon hydrocyanic acid, by L. Claisen and F. E. Matthews. A crystalline substance, having the formula $2HCN+3HCl$, is obtained. By the action of alcohol on this body, the hydrochloride of the base, $HCNHNH_2$, was prepared.

Royal Horticultural Society, April 11.—Dr. M. T. Masters in the chair.—*Rhododendrons:* Mr. Mangles and Hon. and Rev. Mr. Boscawen exhibited species, seedlings, and hybrids of which the following were specially worthy of note:—*R. Forsterianum*—between *R. Edgeworthii* (male) and *R. Veitchianum* (female), raised by M. Otto Forster, of Lebenhof, Austria. It is a beautiful combination of both parent forms, being very large and fragrant. It appears to be quite barren. Hybrid between *R. campylocarpum* (yellow, male) and a crimson hybrid (female). The flowers are pendulous. The yellow tint of the male has nearly gone, but the characters of the flowers are retained. It is pink when first opening, but almost white finally. This hybrid has good pollen, and bears seed.—Hybrid between *R. Thomsoni* and *R. Fortunei*. It is peculiar in having far more flowers in the truss than either parent. It is apparently fertile, and has an abundance of good pollen.—Hybrid between *R. argenteum* and *R. ponticum*. The flower is very inferior to that of the male, which bears large, well-shaped white flowers, being small, tubular, and pink, with aborted anthers. The colour of ponticum being prepotent.—*Hyacinth blossoming underground:* Mr. A. H. Smee, of Wellington, sent a specimen which, in consequence of being under a stone, had blossomed six inches below the surface. The leaves were white, but the flowers a deep purple.—*Plants exhibited: Telopea speciosissima.* Mr. Green, gardener to Sir G. Macleay, exhibited a splendid truss of scarlet flowers and bracts of this proteaceous genus from Sydney, where it is a common shrub, but produces much less fine blossoms there than the specimen exhibited. It was first figured in the *Bot. Mag.* in 1808. He also exhibited a fine specimen of the monkey orchis, from Italy.

EDINBURGH

Royal Society, April 3.—Prof. Balfour, vice-president, in the chair.—Sir William Thomson read a paper on the conditions of stable equilibrium of a rotating mass of gravitating liquid. Laplace had proved that a given moment of momentum in a given mass of fluid of oblate spheroidal form, such as had been shown to be a form of equilibrium by Newton and Maclausin, required for equilibrium a unique value of the excentricity. Jacobi had extended the theorem to the case of an ellipsoid rotating round the shortest of its three unequal axes. By considering the Jacobian ellipsoid which differed infinitely little from a spheroid of revolution, Sir William found a certain value for the moment of momentum such that the equilibrium of the spheroid would be stable if, and only if, its moment of momentum were not greater than this critical value. The conditions under which a disc-shaped ellipsoid would split up into two distinct masses, and the limiting values of the excentricities in the Jacobian figure consistent with stability, were also discussed.—Prof. Tait communicated a note by Prof. C. Michie Smith on atmospheric electricity, which the author had found to be strongly negative on the Suez Canal and in Madras, on occasions when other evident atmospheric conditions would have led one to expect strong positive electrification.—Prof. Chrystal communicated an interesting paper by Mr. A. Jamieson, on recent tests of Swan's lamp for fall of resistance with increase of electromotive force, and ratio of candle-power to work expended. Curves and tables of numbers were shown, giving the relations between these quantities for all the forms of incandescent lamps now in use. The resistance of the lamps when heated was measured by shunting the current through a high resistance galvanometer—Sir W. Thomson's potential galvanometer. The energy expended in keeping the lamps incandescent was estimated, and the results obtained with the incandescent lamps compared with those obtained by other investigators with the arc light.—Dr. A. P. Aitken communicated the results of preliminary observations made by the Committee appointed by the Highland and Agricultural Society to investigate the nature and causes of the two sheep diseases, "Loupingill" and "Braxy." Regarding the former a great variety of opinion existed as to its cause—inclement weather, bad herding, the presence of ergot in the pasture, ticks, &c., being all assigned as possible causes. The committee had concluded, however, that these were merely aggravations, and that the disease was probably due to the presence of an organism located in the cerebro-spinal fluid. The investigations into the nature of Braxy were just begun; but in the coming autumn the committee hoped to continue the inquiry.—Prof. Tait, in the first of three short notes, pointed out the origin of the difficulty of measuring beknottedness electromagnetically. He traced it to the fact that every knot may be looked upon as consisting of separate loops, which may be linked or laced together. When there is linking there is electromagnetic work; when there is lacing, none. In the second he showed that the form of Saturn's shadow on a plane as seen from the earth could be calculated by the same process as that employed for the image of a circle produced by a thin prism; and also, how to determine from the *observed* appearance of the shadow the form of the meridional section of the rings supposed to be surfaces of revolution. Finally he pointed out the analogy between Action in particle-dynamics and Velocity-potential in hydro-kinetics

PARIS

Academy of Sciences, April 8.—M. Jamin in the chair.—The following papers were read:—On the elliptic integral of the third species, by M. Hermite.—Note on the principle of a new photographic revolver, by M. Janssen. In the old instrument the plate is stopped each time an image is taken; in the new, it and the screen with slit have each a continuous rotatory motion. The magnitude and relation of these motions determine the rapidity of succession of the images and the conditions of their formation. The method proved successful with solar granulations. Images may be had at intervals of less than $\frac{1}{100}$ second; thus an insect's flight might be photographed.—Haloid salts of silver and potassium, by M. Berthelot.—On the union of free hydrogen with ethylene, by the same.—On the specific heat of hyponitric acid, by MM. Berthelot and Ogier.—On a thesis of meteorology recently maintained before the Paris Faculty of Sciences, by M. Faye. In this thesis, on the fœhn and the sirocco, M. Hébert has recourse to the theory of descending vortical movements, and M. Faye regards this as a step in advance. Progress would be accelerated (he urges) by giving meteorology a place in the Faculties.—On some types of plants recently observed in the fossil state, by M. de Saporta. These plants are from the Permian of the Oural region, and the Cretaceous of the Fuveau valley (Bouches-du-Rhône).—M. Bert was elected Member in Medicine and Surgery, in room of the late M. Bouillaud.—Researches on the passage of electricity through rarefied air, by M. Edlund. He has proved experimentally that the principal obstacle met by the current at the surface of passage between the electrodes and the rarefied gas, is due to an electromotive force giving an opposite current; which force, beyond a certain limit of rarefaction, continuously increases.—On a class of unicursal curves, by M. Darboux.—On hypercycles, by M. Laguerre.—On uniform doubly periodic functions, with essential singular points, by M. Appell.—On the theory of uniform functions of a variable, by M. Mittag-Leffler.—General relation between any seven points of a conic section; conic of homology; properties common to three homographic figures, by M. Parry.—Study of solar apparatus, by M. Crova. This gives results of a year's experiments by a Government Commission at Montpellier with a solar mirror and boiler; (similar experiments have been made at Constantine). The maxima of yield generally correspond to the minima of intensity of radiations. The absolute quantity of heat utilised depends essentially on the temperature of the air. In our climates it is not possible to reach half the utilisation realisable in the most favourable circumstances; and

the sun does not shine continuously enough to favour the practical use of the apparatus.—On the heat due to magnetisation, by M. Pilleux. He was able to heat, to more than 200°, the iron core of an electro-magnet, with the alternative currents of a Meritens' machine; a non-magnetic core was not heated. Using various iron and steel cores, the coercitive force is proved to increase their heating under frequent magnetisation and de-magnetisation; it acts like resistance to the passage of electricity.—On the absorption-spectrum of pernitric acid, by M. Chappuis. This spectrum is important, especially as a means of verifying that ozone has been prepared with oxygen exempt from nitrogen.—On the electrolysis of distilled water, by M. Tommasi. His experiments prove that water may be electrolysed, even by the current of a very weak battery, provided the calories liberated by this battery are at least equal to the calories absorbed by water in being decomposed, about sixty-nine calories.—On the determination of nitric and nitrous acid in the state of ammonia, by M. Guyard.—On the effects of compression on the hardness of steel, by M. Lan. The compression of fused steel has been practised both in France and England; increasing the hardness and the proportion of combined carbon.—On the composition of hydrated carbonic acid, by M. Wroblewski. At zero temperature and about 16 atm. it consists of 1 eq. of carbonic acid and 8 eq. of water.—On the bisulphydrate and cyanhydrate of ammonia, by M. Isambert.—Action of sulphuretted hydrogen on saline solutions of nickel and metals of the same group, by M. Baubigny.—On ammoniacal chlorides of zinc, by M. André.—On the hydrate of sulphuretted hydrogen, by M. de Foucrand.—Synthesis of quinine, by M. Maumené. The discovery of H_2N furnished him with the means of this synthesis—details of which are not yet given.—Action of fuming nitric acid, and action of hydrochloric acid on pilocarpine, by M. Chastaing. — Gastric microzymas and pepsine; remarks on M. Gautier's note of March 6, by M. Béchamp.—On the existence of products similar to ptomaines in gastric and pancreatic digestion of several albuminoid matters, by M. Béchamp.—Digestion of fatty and cellulosic matters, by M. Duclaux. The emulsion of fatty matters by the pancreas he regards as a phenomenon almost exclusively physical (not produced by diastase). The agents of digestion of cellulose seem to be small rod-like organisms, which one finds in seeds in the crop of birds or the paunch of ruminants. M. Faye recalled former experiments of his own on emulsion.—On the resistance of African asses to charbon fever, by M. Tayon.—Researches on the nervous system of larvæ of dipterous insects, by M. Brandt.—The Alcyonarians of the Bay of Marseilles, by M. Marion.—On the development of the ganglion and the ciliated sac in the bud of Pyrosoma, by M. Joliet.—Artificial reproduction of witherite, strontianite, and calcite, by M. Bourgeois.—On the artificial reproduction of a crystalline hydrated silicate, by M. de Schulten.—On the limit between the lias and the inferior oölite, according to documents left by Henri Hermite, by M. Vélain.

April 10.—M. Blanchard in the chair.—The following papers were read:—On the secular displacements of planes of the orbits of three planets, by M. Tisserand.—Movements acquired by different parts of a liquid within a vessel or reservoir, whence it escapes by an orifice, by M. de Saint Venant.—Philosophical essay on the method named by its author the "Science of order," by M. Villerceau.—Use of instantaneous photography for analysis of movements in animals, by M. Marey. He gives details of his photographic rifle, as applied to birds' flight. A central axis, rotated by clockwork twelve times in a second, when a detent is released, commands all the pieces. There is an opaque disc, with a small hole; behind this a disc with twelve holes, which rotates intermittently; and behind this a sensitised plate, circular or octagonal, on the margin of which the images appear. To get good effects in the phenakistiscope it was necessary to increase the number of images, and M. Marey found 1·1400th second (as against 1·720th before) sufficient exposure. M. Marey found the chief results of his study by the graphic method confirmed. He makes some remarks on bats' flight, which is difficult to photograph.—On some recent types of fossil plants (continued), by M. de Laporta.—Note on the quarantines imposed at Suez on maritime arrivals from the extreme East, by M. de Lesseps. He holds the measures taken are useless and vexatious. The evil (cholera) should be vigorously attacked at the centres of infection formed by the large concourses of pilgrims, and care taken to disinfect putrid dejections, and destroy objects that may have been contaminated.—On the necessity of destroying the winter egg of phylloxera, by M. Balbiani.—On the winter egg of phylloxera, by M. Mayet.—Observations of comet *a*, 1882, at Lyons Observatory (Brünner 6 inch equatorial), by M. Gonessiat.—Observations of the same at the Roman College, by M. Tacchini.—Observations of solar eruptions in 1881; spectrum of Well's comet, by the same. There are two maxima of the former between ± 10° and ± 30°, and more eruptions appeared in the north than in the south; 40 metallic eruptions were observed, against 10 in 1880. (Curves of the solar phenomena are given).—On hypercycles, by M. Laguerre.—On the integration, by Abelian functions, of certain equations with partial derivatives of the first order, by M. Picard.—On Fuchsian functions, by M. Poincaré.—On the theory of uniform functions of a variable, by M. Mittag-Leffler.—On general inversion, by M. Vanacek.—Resistance of a prismatic and homogeneous bar, of supposed infinite length, to transversal shock and longitudinal shock, by M. Boussinesq.—Experimental researches on the thermal conductivity of minerals and rocks, by M. Thoulet. The novelty of his method (applied to glass, forged iron, and anhydrite) consists in substituting a precise estimation of times for determination of temperatures.—Evaluation of thermal conductivity by measurement of times during a variable period, by M. Lagarde.—On electrolysis, by M. Tommasi. He proves the law that when a voltaic current traverses several electrolytes, it is necessary (for decomposition to occur) that the quantity of calories produced by the pile be equal to the sum of the calories absorbed by each electrolyte *plus* the calories required to overcome the total resistance of the electrolytes.—Researches on the solubility of aluminates of lime in water; influence of this on the final hardening of hydraulic materials, by M. Landrin.—On the relation between isomorphism, atomic weights, and comparative toxicity of metallic salts, by Mr. Blake. His experiments (in which the substances were introduced directly into the blood) prove, in opposition to M. Richet, an intimate connection between chemical function and physiological action.—On some physical properties of bichlorised camphor, by MM. Cazeneuve and Didelot.—Peptones and alkaloids; reply to M. Béchamp, by M. Tanret.—On the rapidity of propagation of the inoculated bacterium of charbon, by M. Rodet, with M. Davaine. He found great irregularity in the effects of destruction of the inoculated part.—The puceron of Latania, by M. Lichtenstein.—On the density and the chlorination of sea-water obtained in the *Travailleur* in 1881, by M. Bouquet de la Grye. The density and saltness are shown to increase on passing from the ocean to the Mediterranean. The surface-waters are less salt and dense than the lower, and generally the increase varies in the same sense as the depth. Measurements of density at 400 m. depth, opposite the Rhone mouth, and in the Gulf of Gascogne, indicated a difference of height of 0·72 m. (agreeing with M. Bourdalone's observations).—On a recent communication of M. Dieulafait, on ophitic rocks of the Pyrenees, by M. Virlet d'Auost.

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THURSDAY, APRIL 27, 1882

CHARLES DARWIN

VERY few, even among those who have taken the keenest interest in the progress of the revolution in natural knowledge set afoot by the publication of the "Origin of Species"; and who have watched, not without astonishment, the rapid and complete change which has been effected both inside and outside the boundaries of the scientific world in the attitude of men's minds towards the doctrines which are expounded in that great work, can have been prepared for the extraordinary manifestation of affectionate regard for the man, and of profound reverence for the philosopher, which followed the announcement, on Thursday last, of the death of Mr. Darwin.

Not only in these islands, where so many have felt the fascination of personal contact with an intellect which had no superior, and with a character which was even nobler than the intellect; but, in all parts of the civilised world, it would seem that those whose business it is to feel the pulse of nations and to know what interests the masses of mankind, were well aware that thousands of their readers would think the world the poorer for Darwin's death, and would dwell with eager interest upon every incident of his history. In France, in Germany, in Austro-Hungary, in Italy, in the United States, writers of all shades of opinion, for once unanimous, have paid a willing tribute to the worth of our great countryman, ignored in life by the official representatives of the kingdom, but laid in death among his peers in Westminster Abbey by the will of the intelligence of the nation.

It is not for us to allude to the sacred sorrows of the bereaved home at Down; but it is no secret that, outside that domestic group, there are many to whom Mr. Darwin's death is a wholly irreparable loss. And this not merely because of his wonderfully genial, simple, and generous nature; his cheerful and animated conversation, and the infinite variety and accuracy of his information; but because the more one knew of him, the more he seemed the incorporated ideal of a man of science. Acute as were his reasoning powers, vast as was his knowledge, marvellous as was his tenacious industry, under physical difficulties which would have converted nine men out of ten into aimless invalids; it was not these qualities, great as they were, which impressed those who were admitted to his intimacy with involuntary veneration, but a certain intense and almost passionate honesty by which all his thoughts and actions were irradiated, as by a central fire.

It was this rarest and greatest of endowments which kept his vivid imagination and great speculative powers within due bounds; which compelled him to undertake the prodigious labours of original investigation and of reading, upon which his published works are based; which made him accept criticisms and suggestions from any body and every body, not only without impatience, but with expressions of gratitude sometimes almost comically in excess of their value; which led him to allow neither himself nor others to be deceived by phrases, and to spare neither time nor pains in order to obtain clear and distinct ideas upon every topic with which he occupied himself.

One could not converse with Darwin without being reminded of Socrates. There was the same desire to find some one wiser than himself; the same belief in the sovereignty of reason; the same ready humour; the same sympathetic interest in all the ways and works of men. But instead of turning away from the problems of nature as hopelessly insoluble, our modern philosopher devoted his whole life to attacking them in the spirit of Heraclitus and of Democritus, with results which are as the substance of which their speculations were anticipatory shadows.

The due appreciation or even enumeration of these results is neither practicable nor desirable at this moment. There is a time for all things—a time for glorying in our ever-extending conquests over the realm of nature, and a time for mourning over the heroes who have led us to victory.

None have fought better, and none have been more fortunate than Charles Darwin. He found a great truth, trodden under foot, reviled by bigots, and ridiculed by all the world; he lived long enough to see it, chiefly by his own efforts, irrefragably established in science, inseparably incorporated with the common thoughts of men, and only hated and feared by those who would revile, but dare not. What shall a man desire more than this? Once more the image of Socrates rises unbidden, and the noble peroration of the "Apology" rings in our ears as if it were Charles Darwin's farewell:—

"The hour of departure has arrived, and we go our ways—I to die and you to live. Which is the better, God only knows."

T. H. HUXLEY

PROF. WIESNER ON "THE POWER OF MOVEMENT IN PLANTS"[1]

Das Bewegungsvermögen der Pflanzen: eine kritische Studie über das gleichnamige Werk, von Charles Darwin, nebst neuen Untersuchungen. Von Julius Wiesner. 8vo, pp. 212. Three Woodcuts. (Wien: Hölder, 1881.)

LIGHT as a Stimulus.—In "The Power of Movement" (p. 458) we observed the heliotropic curvature of a number of seedlings placed at 2, 4, 8, 12, 16, and 20 feet from a lateral light, and we came to the conclusion from inspection that the difference in heliotropic effect was not proportional to the intensity of light which the different sets of plants received. We think that this fact shows that light acts as a stimulus in causing heliotropism; if it acted in a simple physical manner the effects would bear some closer relation to the intensities of the causes.

Wiesner criticises this conclusion, and says (p. 78) that the fact is capable of a simple physical explanation. Wiesner has discovered that when plants are subjected to extremely bright light, they do not bend so much as when the light is slightly weaker (optimum for heliotropism); then as the light becomes weaker still, the heliotropic curvature again diminishes. This fact is supposed to be explicable by assuming the existence of certain negatively heliotropic elements. As far as I understand him, Wiesner does not allude to this question when he speaks of there being a simple explanation of the relationship between

[1] Continued from p. 582

intensity of light and amount of curvature; and an explanation which requires so large an assumption cannot be considered a simple one. I shall therefore at present neglect the existence of the optimum, and consider the heliotropic curvatures produced by degrees of light all below the optimum. Here we see plainly enough that the intensity of the light is by no means proportional to the curvature.

Now Wiesner's explanation is that "the difference of illumination on the lighted and shaded sides, which causes the unequal growth leading to heliotropism is not proportional to the intensity of the light." This statement is in opposition to the laws of Optics. If J is the intensity of light per unit of surface, illuminating the light side, then the amount of light absorbed in passing through the plant is a certain proportion of J (call it A J), therefore the illumination on the darker side is $J - AJ = J(1 - A)$; and the difference between the illuminations on the two sides is A J, that is to say, the difference is proportional to the intensity of the light. [The proportion between the two intensities is $\frac{J}{J(1-A)} = \frac{1}{1-A}$, which is constant.]

Wiesner might connect the heliotropic facts with his observations on the amounts of longitudinal growth under different intensities of light (Monograph, Part ii. p. 12 and following pages); but this is only pushing the difficulty one step further back. The fact remains that the way in which growth is checked by light does not resemble the effect of light on photographic paper, but is more like the effect of light on sensitive animal tissues.[1]

Sachs and his pupil Müller Thurgau made known long ago the important phenomena of "Nachwirkung," or *after-effect*. If a plant is laterally illuminated for a certain time and then placed in the dark, the curvature will be continued in the same direction as though light was still acting on it. Or if, instead of being darkened, it is simply turned round, so that the direction of the light is reversed, the plant will go on curving in the direction in which it has begun to do so, in spite of the light now illuminating the opposite side. This phenomena we compared with the after effect of light on the retina. But Wiesner will not allow this comparison, chiefly because he finds an analogy between the after effect of light on plants and the photo-chemical induction of Bunsen and Roscoe (Wiesner's Monograph, i. p. 66). But we may just as well say that the effect of light on the *retina* is comparable to photo-chemical induction. We should then be able not only to say that light may in some respects act in a similar way on plants and animals, but (thanks to Wiesner) we should be able to form a theory as to why this is so.

In the "Power of Movement" we recorded our belief that plants are sensitive to the successive contrast of light and darkness, and this seems to us another point of resemblance between the sensitiveness of plants and animals. Thus, plants which have been exposed to the daylight did not become so quickly heliotropic as others, which had been kept in darkness. Again, consistently with this view, we attributed the striking effects of intermittent light to the increased sensitiveness of plants kept in the dark.

With respect to the effect of intermittent light, Wiesner states that the heliotropism produced by intermittent light is not *greater* than that due to constant illumination. The fact that so much heliotropic curvature is produced, is supposed to be due to the after-effect of the periods of illumination being continued through the periods of darkness, and thus producing an effect equivalent to continuous illumination. This naturally occurred to us, and it may possibly be the correct explanation.

Our statement that plants are more sensitive to light if they have been kept in the dark, Wiesner considers to be well known to be true, in the case at least of etiolated plants. He explains it by the increased capability for growth which is produced by darkness. On the other hand, he quotes an experiment from his "Monograph" to show that a plant subjected to equal illumination on all sides is rendered more sensitive heliotropically than a plant grown in the dark. This fact he considers as quite destructive of our view on the effect of contrast. He explains the result as follows.

The turgescence of the cells of an organ offer a certain resistance to its curvature, and therefore anything that slightly diminishes the turgescence increases the power of bending heliotropically; and as bright illumination diminishes turgescence, it may be expected to increase the heliotropic sensitiveness. This is such a contradiction to his explanation of our results and to other statements of his, that I should be inclined to think that I have misunderstood him. But we have on the same page (p. 83) our observations explained as the result of the increased "capacity for growth" caused by darkness, while his own observations are explained by diminished turgescence, which must imply diminished capability for growth as its chief result. If Wiesner explains his own observations correctly, he cannot explain ours, and therefore his criticism is deprived of all force.[1]

Geotropism—Sensitiveness of Root-tips to Gravitation.—If the extreme tip of a root (1 to 1·5 mm.) be cut off, the root will continue to grow vigorously, but it ceases, or almost ceases, to be geotropic.[2] We concluded that when a root is placed horizontally, the force of gravity acts on the tip, and a stimulus is transmitted to the growing part of the root, causing it to bend down. And that accordingly when the root-tip is destroyed the root is incapable of receiving the stimulus of gravitation. Wiesner differs entirely from this point of view, and believes that the diminished geotropism of the pointless roots is simply due to their diminished activity of growth due to the injury. I have elsewhere treated this question experimentally, and have been able to show that if the tip is not cut off roots may be very severely injured in other ways, so that the growth is greatly retarded, and that they are nevertheless capable of geotropic curvature. I have thus shown that Wiesner's explanation of the facts cannot be the right one, since mere retardation of growth is not sufficient to account for loss of geotropism.

Sensitiveness of Root-tips.—In "The Power of Movements" we showed that the tips of roots are stimulated in a peculiar manner by the continued contact of small squares of cardboard cemented to one side of the extreme tip of the root. It was found that the root curved

[1] Of course no one denies that stimulation ultimately depends on the physical properties of the sensitive tissue.

[1] It should also be observed that Wiesner's experiments were made with etiolated plants, which was not the case with ours. It appears (Monograph, p. 8) that in *V. Faba* and *Soja hispida* no increase of heliotropic sensibility was produced by illumination.

[2] "Power of Movement," Chap. x. The original experiment on this point is due to Ciesielski.

away from the side on which the card was fastened, so that in some cases the root made complete loops by its continued curved growth. We believe that the tips of roots are sensitive to contact, and that when a root meets with an obstacle in its way the pressure on one side of the tip causes the growing part of the root to grow more rapidly on the side of the obstacle, and thus curve away from it. It is conceivable that a root should curve away from an obstacle, owing to the forcible bending of the root, just as any other ductile object would give way when forced against a fixed object It was from observing roots bending away from fixed obstacles placed in the way of their growth that we were led to suspect that the curvature was not due to forcible bending, but to a special kind of curvature, due to stimulus transmitted from the sensitive tip.

Wiesner confirms our facts, but differs entirely in his interpretation of them. His explanation rests on certain facts observed by us, namely, that if the extreme apex of a root be wounded on one side by an oblique cut with a razor, or by a touch with lunar caustic, the same curvature occurs as when pieces of card are attached. Wiesner believes that the spirits of wine contained in the shellac varnish which was used in many of the experiments to fasten on the cards, injures the root on one side, and that this accounts for the curvature which we ascribe to contact. But Wiesner's criticism is incomplete on this point. He takes no notice of the experiments in which we used thick gum, instead of shellac varnish, for attaching the pieces of card to the tips of the roots. It is difficult to believe that gum injures the roots, since gum by itself produces no effect ; and it seemed pretty clear that it was the card, and not the gum, which acted, for when, as often occurred, the gum absorbed water and swelled up so that the card was separated from the root, no effect was produced. Nor does Wiesner mention our experiment in which the shellac varnish was not attached directly, but to a small piece of gold-beater's skin applied to the root.

If Wiesner's view is correct, then since the thick shellac varnish which we used hardens on the surface in a few minutes, it is clear that the injury to the root must take place in this short period. This however has not been shown to be the case.

Wiesner makes a great point of an experiment in which he causes small pieces of wood (p. 144) and sand to adhere, by pressing them against one side of the root-tip without using shellac : under these circumstances he says that no curvature took place. This experiment does not seem to me so important as Wiesner would have us believe, but for reasons given in the next paragraph I defer further discussion of the whole question.

A few words must be given to some of Wiesner's other experiments on this subject. He caused roots to grow against various more or less yielding objects in such a way that he could estimate the pressure against the root-tip, and found that the root did not bend from the touching obstacle till the pressure is sufficient to cause forcible bending. Here Wiesner's experiments seem not to be quite conclusive, and I have begun to make experiments which I hope will prove to be crucial. But I have been obliged to stop, because of the curious want of sensitiveness in the tip of the root which has occurred in a large proportion of the beans tried. I have repeated the experiment of fastening on pieces of sand-paper with shellac to one side of the root-tip, and in the large majority of cases no curvature ensued. I have no means of knowing what the meaning of this failure may be (I am inclined to believe it is owing to the experiments being made in the winter), but it is clearly useless to pursue the experiments with such abnormal material.

Wiesner seems to be in doubt whether or not the curvature of the root away from the injured side implies that a stimulus travels from the sensitive tip to the growing part of the root, whether, in fact, the injury to the root acts as a stimulus. The alternative proposed by Wiesner (p. 145), and which he thinks more probable, is that in consequence of injury, "the uninjured part of the root gets into a state which directly increases its capability of growth without any stimulus coming into action." Wiesner's conception of stimulus ("Reiz") is not quite easy to understand, thus, for instance his definition of "Reiz" ("Elemente der Anat. und Physiol. der Pflanzen," 1881, pp. 249, 250) is an "influence whose mechanical efficiency (Leisting) is out of proportion to the resulting mechanical effect. A stimulus in this sense does not directly cause the movement, it merely releases the efficient forces, just as the pressure of a finger on the trigger of a gun produces the explosion indeed, but stands in no relation to the force with which the ball is driven through the barrel." In accordance with this definition he describes ("Anatomie," p. 253) the nocturnal (nyctitropic) movements of the leaves of Robinia as "a phenomenon of stimulation (Reiz-erscheinung) depending on differences of Turgor." Again, in his present work ("Bewegungsvermögen") he gives (p. 25) a definition of "Reiz," which is essentially the same as that already given. He adds, however, the characteristic of transmission to his definition :—"Every irritable part has the power of transmitting the stimulus to neighbouring parts which are also usually irritable." He goes on to say that the sleep-movements of leaves do not realise the characteristics of a Reiz-Erscheinung, thus contradicting what he says in his other work.[1] Whether we take the first or the second definition, it seems surprising that Wiesner should doubt that the curvature of a root when its tip is injured is a phenomenon of stimulation. If it were, as Wiesner is inclined to believe, the direct mechanical effect of the injury, the result would be curious ; for if injuring one side of the root causes increased growth on the same side as the injury, it is clear that injuring both sides symmetrically ought to increase the whole growth of the organ. And accordingly when the tip is cut off by a section perpendicular to the axis of the root, its growth ought to be accelerated ; which would be directly contrary to the results of Wiesner's experiments on this point.

Symmetrical injury to the tip looked at from our point of view could not of course be expected to lead to consequences of this sort.

The next chapter in Wiesner's book begins with the question of "spontaneous" nutations, and under this heading occur the hook-like curvatures of the ends of shoots of Ampelopsis. This curvature Wiesner considers

[1] It seems to me inconceivable that a stimulus should act indirectly by releasing potential energy, as in the case of discharging a gun, unless some kind of transmission of the stimulus takes place ; and if this is so, Wiesner's two definitions are identical.

to be due to the weight of the end of the shoot; we ascribed it to epinasty, because on horizontal and inclined branches the hooked tip does not necessarily point vertically downwards, but is often horizontal, or points upwards (Power of Movement, p. 272). Wiesner on the other hand states that all the ends of shoots observed by him at the season when the Ampelopsis is growing vigorously pointed downwards; this fact would gain in value if it were stated that the observations included horizontal branches. On the same page he remarks that the downward directed shoot often goes far beyond the vertical, and this, as well as the vertical position seen in other cases, is explained by "Zugwachsthum" (*i.e.* "growth produced by strain"), due to the weight of the shoot. How this can possibly be the case is not explained.

Diaheliotropism.—The power possessed by many leaves of placing themselves at right angles to the direction of incident light was called *Transversal Heliotropismus* by A. B. Frank; we have called it diaheliotropism, partly for the sake of convenience and of uniformity in nomenclature, and partly because our view does not exactly coincide with Frank's. Wiesner asserts positively that diaheliotropism does not exist, and that all the phenomena can be explained as the result of the balance of ordinary forces, positive and negative, heliotropism, positive and negative, geotropism, epinasty, hyponasty, weight, &c.

The main features of Wiesner's explanation are as follows:—We are supposed to have a vertical bud whose leaves are bending epinastically down towards the horizontal position, which they ultimately assume when the light comes vertically from above. In this stage of growth before the position of the leaves is determined by that of the light, Wiesner speaks of the possibility of a balance being struck between epinasty and apogeotropism. But Frank (*Bot. Zeitung*, 1873, p. 22) has long ago shown the impossibility of a balance being struck between a constant force like epinasty, and a force (and this would apply to apogeotropism) which varies with the position of the organ with regard to the horizon.

To continue Wiesner's explanation: when the plant is exposed to a zenith illumination, the leaves bend downwards owing to apheliotropism, and if truly apheliotropic, would continue to bend till they pointed vertically downwards. But Wiesner believes that the light, besides causing apheliotropic movement in the leaves, has the power of checking their apogeotropism. If therefore the leaves in moving downwards go beyond the horizontal position, they become obliquely illuminated, and accordingly the light being weaker, the inhibition of apogeotropism is lessened, and the leaves rise up. What occurs if the leaves, in this upward movement, go beyond the horizontal is not explained, for in this case also the apogeotropism would be diminished. To explain this it would be necessary to make more assumptions as to the variations in apheliotropism due to the varying obliquity of light, and the variations in apogeotropism due to varying positions of the leaves with regard to the horizon; and no such assumptions are made by Wiesner. The faultiness of Wiesner's explanation is made clear by the following example. Let us assume that Wiesner's explanation holds good for zenith illumination, and suppose that a seedling dicotyledonous plant under these conditions is suddenly subjected to oblique light. Then both that cotyledon which is on the illuminated side, and the one on the shaded side will be obliquely illuminated, therefore, according to Wiesner, the apogeotropism of both cotyledons will be increased, and both should rise up; but what really happens is that one falls and the other rises. This seems inexplicable, unless we suppose that the apheliotropism of the leaves differs according as the light falls, as shown by arrow No. 1 or No. 2 in Fig. 2.

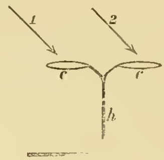

FIG. 2—Diagram representing a seedling dicotyledon exposed to oblique light. *h*, the hypocotyl, or stalk; *c*, *c*, the cotyledons; the arrows represent the direction of the light.

Wiesner's explanations are also shown to be untenable, at least in some cases, by my observations "On the Power possessed by Leaves of placing themselves at Right Angles to the Direction of Incident Light" (*Journal* of Linn. Soc., vol. xviii., 1881). I have there shown that certain plants are able to place their leaves at right angles to incident light when removed from the action of apogeotropism. These experiments are not discussed by Wiesner, and would seem to be inexplicable from his point of view. When engaged in this work on diaheliotropism I was struck with the impropriety of considering as heliotropic all movements towards a source of light, or all movements away from it as negatively heliotropic. Thus the leaves of *Ranunculus ficaria* move either towards or from the light (independently of gravitation), according as either of these movements is required to place the leaves at right angles to the direction of the incident light. And it is obviously impossible to call the leaves both negatively *and* positively heliotropic. It is far more rational to call them diaheliotropic, and there is no more objection to the use of this term than there is to the terms heliotropism or apheliotropism; all such terms are confessions of ignorance, and none of them exclude further research into the phenomena to which they are applied.

Diageotropism.—As a diaheliotropic organ is one which possesses the power of placing itself at right angles to the direction of incident light, so a diageotropic organ is one which possesses the power of growing at right angles to the line of gravitation. Thus certain underground stems possess the power of growing horizontally beneath the surface, instead of vertically upwards, like most stems.

In Wiesner's few remarks on this subject, he completely ignores Elfving's remarkable paper on horizontally-growing rhizomes, which we especially referred to, and which is by far the most striking evidence which we possess in favour of the existence of diageotropism.

Hydrotropism.—Roots have the power of bending towards a wet surface, and we have shown, that when the tip of the root is covered with a layer of grease, the root does not usually bend towards the wet surface, from which we inferred that the sensitiveness to moisture resides in the tip. Wiesner believes that the treatment to which the tip of the root is subjected, lessens the power

of growth of the root, and that the loss of hydrotropism is a consequence of the less vigorous growth in the root; this is practically the same criticism as that which Wiesner has applied to our views on geotropism; namely, that the lessened rate of growth caused by the injury to the *punctum vegetationis* interferes with the power of geotropic curvature.

Wiesner has, however, himself observed the fact that the *less* turgescent roots are those which seem to exhibit hydrotropism best, and as want of turgescence would certainly interfere with normal growth, fully as much as the grease on the tips of the roots, Wiesner's criticism seems to be considerably weakened.

In a notice of the present extent, it would be impossible to notice all Wiesner's experiments and arguments, many of which possess much interest. To do so, would require a whole volume such as Wiesner has devoted to the subject, and to which I must refer those who wish to be better acquainted with his views. Finally, I would ask those who do so, not to forget to refer to "The Power of Movement in Plants," for it is only by studying the two books together, that an adequate opinion on the questions at issue can be formed.

FRANCIS DARWIN

OUR BOOK SHELF

Catalogue of the Batrachia, Salientia and Ecaudata in the Collection of the British Museum. By George Albert Boulenger. (London: Printed by Order of the Trustees, 1882.)

THIS volume is a proof of the steady though rapid progress which our great Natural History Collection is making, and is a token as well that under the present keeper of the Zoological Department, the stores of specimens will be made fully available for scientific reference. To the working zoologist there can be no more acceptable gift than such carefully compiled catalogues, and by the publication of such the collection itself not only indirectly but even directly benefits, for an interest is awakened in the objects described, and thereby the stream of donations begins to flow. The first edition of this Catalogue, published in 1858, contained the description of some 283 species, and the collection consisted of some 1691 specimens. The present edition contains the description of 800 species, of which the British Museum possesses 522, represented by some 4692 specimens. The first edition, by Dr. Günther, without doubt gave a great impulse to the study of the tailless Batrachians, and as a result it is now out of date. For the present edition Dr. Günther has been fortunate in securing the services of Mr. Boulenger, the assistant naturalist in the Royal Museum of Belgium, and exceedingly well has the latter accomplished his task. The classification adopted is based on that of Mr. E. D. Cope, somewhat modified, and biologists in general will be pleased to know that this classification seems to harmonise not only with the natural affinities of the genera, but with all that is known of the geographical distribution, development, and physiology of the group. The only serious objection urged against it is the supposed difficulty of ascertaining on the recent specimens the osteological characters, without sacrificing one or more specimens; but, as Mr. Boulenger asserts, it requires only a moderate skill and two or three clean incisions to reveal all the required secrets of the structure of the vertebræ.

One important feature in this catalogue is that we find in it an account of all the known species of the group, so that it to a great extent possesses the merit of being a monograph, and it thus indicates the species which are wanting in the National collection. There is also a very considerable beginning made in the descriptions of the larval forms, and sometimes these are figured, the collecting of these forms we trust may receive a fresh stimulus from the publication of this work.

Mr. Boulenger well merits the confidence with which Dr. Günther writes that "zoologists will thankfully acknowledge the industry and ability with which the author has performed his difficult task."

It only remains to add that this catalogue is illustrated with numerous woodcut illustrations, and with thirty lithographic plates.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

On the Conservation of Solar Energy

WITH your permission I should like to offer a few remarks upon the interesting paper of Dr. C. William Siemens on the "Conservation of Solar Energy," published in NATURE (vol. xxv. p. 440). The main hypothesis upon which that paper is based, that of a fan-like action of the sun, is not improbable; nor are the consequences drawn illogical, if we could reasonably imagine space to be occupied by such condensed molecules as he supposes. That space is everywhere occupied by matter, there is no just reason to doubt. The hypothesis of an ether, specifically distinct from matter, is a gratuitous assumption, and one of the last surviving relics of eighteenth century science. Unless it can be proved that highly disintegrated matter is positively incapable of conveying light vibrations, there is no warrant for assigning this duty to a distinct form of substance. But that matter exists in outer space in the same conditions as in the planetary atmospheres is certainly improbable. Its duty as a conveyer of radiant vibrations seems to require a far greater tensity, and its disintegration is probably extreme.

If we assume, then, that matter exists throughout the universe, here as condensed spheres, there as highly rarefied substance, with the atmospheric envelopes of the spheres gradually shading off into the excessively rare matter of mid space; another hypothesis may be deduced, somewhat different to that offered by Dr. Siemens. The views which I desire to present have been already published, but they seem worthy of repetition in connection with his solar theory.

On the Nebular hypothesis, the matter of the sun was once disseminated through space. Gravitative attraction has, therefore, had a double effect. The greater portion of this matter is now drawn together into a contracted mass. The remaining portion yet occupies outer space, in a far more rarefied condition than the original. But an important consequence attends the condensation and rarefaction of gases. This is, that condensed gases become heated, rarefied gases cooled, and this without the aid of heat exchange with outer material. In the one case a portion of the absolute heat of the gas, formerly latent, becomes sensible; in the other a portion of the sensible heat becomes latent. If originally the absolute heat contents and the temperatures were alike equal, condensation and rarefaction would not, of themselves, change the heat contents, but they would change the temperatures. In condensation, the latent heat is reduced, the sensible heat increased, and the temperature rises. In rarefaction the opposite effect is produced, and the temperature falls.

This consideration applies as well to the problem of the condensation of nebulous as of terrestrial gases. The effect of contraction of nebulous gas into a dense sphere, must be a considerable rise in temperature if there be no diminution of absolute heat contents. The effect of rarefaction of the remaining matter of space must be a decrease in temperature. Thus if radiant outflow of heat from the sun had been prevented during its condensation, the eventual result must have been that the sun and the matter of outer space would have continued equal, mass for mass, in absolute heat contents, and yet have become immensely different in temperature.

And from this must have come another interesting result,

namely, that their degree of disintegration would continue the same. There could be no more chemical combination in the sun, if thus retaining all its heat, than in the rare matter of space. For chemical condensation to take place the heat contents must be reduced. An equal degree of absolute heat signifies an equal motive vigour of particles, and it is this motive vigour which enables them to resist chemical attraction. It may be supposed, however, that in dense matter the chemical attraction would be more effective from its increased energy through contiguity. Yet this is an erroneous idea; there is no real greater contiguity between the particles of dense than of rare matter. In both cases, the particles are brought incessantly into absolute contact through their vibrations. The number of contacts of dense as compared with rare matter may be millions to one, but that can have no effect upon the result. If the chemical vigour be stronger than the vibratory vigour it will overcome it in the contact; if it be weaker it will fail to overcome it, and a more frequent repetition of contacts cannot materially aid this result.

Thus all substances of equal absolute heat must be equal in degree of chemical integration, whatever their degrees of tensity or condensation. But the assumed equality of absolute heat cannot continue between dense and rare gases. The sensible heat of the dense gas tends to radiate out into the chilled rare gas. A constant and vigorous effort to equalise temperatures takes place. With every outflow of radiant heat from a sphere into space the absolute heat of the particles of the sphere decreases, that of the rare matter of space increases. The absolute heat contents grow more unequal with every step towards equalisation of temperatures. Consequently a variation in chemical condition arises. The loss of heat by the sun, for instance, reduces the vibratory resistance to attraction, and with every such loss chemical molecules of greater complexity are formed. This heat is radiated into space. Probably some portion of this radiant heat is arrested and becomes local heat in the matter of space. If so the heat vigour of this matter increases, disintegration must ensue, and the increasing chemical condensation in the sun must be matched by an increasing chemical disintegration in outer matter.

During the myriad years of solar condensation, this process of heat-outflow has been continuous, so that now, despite its great excess of temperature, the absolute heat of solar matter must be far below that of an equal mass of the matter of outer space. Can the heat thus lost by the sun be recovered? If it could, the solar heat emissions might continue indefinitely. Dr. Siemens' hypothesis offers a method of recovery. If the matter of outer space is drawn into the solar atmosphere by such a polar inflow as he supposes, and subjected to the vigorous condensing influence of solar gravity, its volume must be very greatly decreased, and much of its latent heat become sensible. And as its absolute heat-contents are far in excess of those of solar matter, the result of such condensation must be a high degree of temperature, and a continual replacement of the radiated heat of the sun. Without any chemical integration taking place in this inflowing matter, the solar temperature may be kept up by its mere condensation, and by rendering available its great excess of absolute heat. With chemical integration, and the consequent much greater condensation, of course the heat-yielding effect must be much more considerable.

This inflow of outer matter to the sun is, in Dr. Siemens' hypothesis, rendered possible by a continuous outflow of solar matter to outer space, thus carrying substance of low heat energy to be mingled with the rarefied exterior matter, whose high heat energy is thereby somewhat reduced. Such a process, however, has in it something of the flavour of perpetual motion. The sun is giving and taking, and its receptions may be equal to its emissions. It would thus constitute a machine yielding power to, and regaining power—to be again yielded—from the same substance. Yet there is another element in the case, which relieves it of this suspicious perpetual motion flavour. If the sun is constantly flinging off rare matter at a tangent from its upper atmosphere, there must be a reaction upon the rotatory energy of the solar sphere. It must be gradually losing its energy of rotation, with extreme slowness, of course, since the weight thrown off is very slight, but in time the effect cannot but become a marked one, and perhaps this loss of solar energy may be the ultimate source of the new heat obtained by such a process. We may conceive of a like process taking place, to a less marked extent, in the large and rapidly rotating planets, such as Jupiter.

CHARLES MORRIS

Philadelphia, U.S.

UNDER this title Dr. C. W. Siemens, on March 2, presented to the Royal Society a paper, which is published in NATURE, vol. xxv. p. 440. Therein, after noticing the hypotheses proposed by Meyer, Helmholtz, and Sir William Thomson, to explain the maintenance of solar heat, he endeavours to show how the energy apparently lost by radiation from the sun into space, may be gathered up and restored to the centre of our system. This he conceives to be effected through the intervention of attenuated matter diffused throughout space, which is the recipient of the radiated energy, and is continuously absorbed and again reflected by the centrifugal action of the sun itself. The matter diffused through space he supposes to include oxygen and nitrogen, hydrogen, aqueous vapour, and carbon compounds, besides solid materials which are probably exhalations from the sun, and constitute the so-called cosmic dust.[1]

In support of this view of an interstellary nature Dr. Siemens cites Grove and Mattieu Williams, among others, but does not seem aware that its agency in gathering up and restoring to the sun its lost radiant energy, has been maintained by these writers. Sir William Grove, in his address as President of the British Association in 1866, attempted to find in this interstellar matter (whose nature and relations to our atmosphere he had already considered in 1843, in his celebrated essay on "The Correlation of Forces"), a source of solar heat, inasmuch as the sun "may condense gaseous matters as it travels in space, and so heat may be produced." This same view suggests the title of "The Fuel of the Sun," by Mattieu Williams, a book published in 1860, the argument of which, as briefly resumed by me in an essay on "The Chemical and Geological Relations of the Atmosphere," in the *American Journal of Science* for May, 1880, is as follows:—

"The solar heat, according to Williams, is maintained by the sun's condensation of the attenuated matter everywhere encountered by that body in its motion through interstellar space. The irregular movements impressed upon the sun by the varying attractions of the planets, stirring up and intermingling the different strata of the solar atmosphere, and producing the great perturbations therein, of which the telescope affords evidence, are, in his hypothesis, the efficient agents in the process. The diffused matter or ether, which is the recipient of the heat-radiations of the universe, is thereby drawn into the depths of the solar mass; repelling thence the previously condensed and thermally-exhausted ether, it becomes compressed and gives up its heat, to be, in turn, itself driven out in a rarefied and cooled state, and to absorb a fresh supply of heat, which he supposes to be, in this way, taken up by the ether, and again concentrated and redistributed by the suns of the universe."

The astronomer must judge between the different views of the mechanism of what may be called the process of solar respiration in this hypothesis, as put forward by Siemens and Williams respectively. We may call attention in this connection to Newton's "Principia," book iii., proposition 12.

The views of Grove and of Williams, cited in my paper of 1880, are farther considered in an essay on "Celestial Chemistry from the time of Newton," read by me in November, 1881, before the Philosophical Society of Cambridge, and reprinted from its *Proceedings* both in the *Chemical News* and the *American Journal of Science* for February, 1882. A perusal of this paper, to which Dr. Siemens alludes, will show that Sir Isaac Newton 200 years ago conceived the existence of an interstellar ether made up in part from emanations and exhalations from the atmospheres of the earth, the planets, and the sun, and from comets. He further conjectured this interstellary medium to contain "the material principle of life" and "the food of sun and planets," furnishing "the solary fuel," and being copiously absorbed by the sun "to conserve his shining." The relations of this interstellary matter to terrestrial life I have endeavoured to set forth in the paper just noticed. In connection with Sir William Thomson's calculation of the density of the luminiferous medium therein mentioned, the reader is referred to a recent examination of the subject by P. Glan, in the *Annalen der Physik und Chemie*, No. viii. 1879, in which he concludes that the lower limit of density would be more than 7000 times greater than that calculated by Thomson.

[1] In a paper on the subject of an interstellar medium, read by me before the French Academy of Sciences (*Comptes Rendus*, September 23, 1878, page 453), I spoke of it as affording, in accordance with the ideas of Newton and of Grove, a means of material communication between celestial bodies and added: "Cette théorie d'une échange universelle me paraissait fournir une explication de l'origine des poussières cosmiques."

Dr. Siemens has, in his paper, further suggested that solar radiation may effect the dissociation in interstellar space of the compounds of oxygen with carbon and with hydrogen, so that these elements may reach the sun in an uncombined state, and there be burned. He would thus make the sun not only a compressing-engine, but a furnace. While such a dissociation in outer space is not impossible, it is to be said that a preliminary decomposition, followed by reunion in the solar sphere, would in no way augment the ultimate calorific effect of compression there. The elements in the act of dissociation in space would absorb just as much radiant energy as would be set free by their subsequent combination, so that, whether the solar radiations are expended in heating or in dissociating the diffused matter, the final result in the sun would be the same. It may be further remarked, that from what we know of solar chemistry, dissociation of aqueous vapour and of carbonic dioxide is more likely to take place in the sun itself than in the cold regions of outer space.

While, therefore, his suggested addition to the hypothesis seems, if not untenable, unnecessary, we are grateful to Dr. Siemens for again bringing before us the grand conception which dawned upon the mind of Newton, but has found its fuller expression in our own day, and, as I have endeavoured to shew in the papers already noticed, gives us the elements of a rational Physiology of the Universe. T. STERRY HUNT

Montreal, Canada, April 3

THE two preceding letters by American men of science of well-known position, grant one of the three postulates upon which I grounded my solar plan, that of space filled with attenuated matter; they do not object to the second, and all-important one of the equatorial outflowing current; but they call in question the necessity of the third, that of dissociation of attenuated matter in space by means of arrested solar energy. Both my critics think dissociation in space unnecessary for the maintenance of solar energy, or as Dr. Sterry Hunt very clearly puts it: "Whether the solar radiations are expended in *heating* or in *dissociating* the diffused matter, the final result in the sun would be the same."

I would be disposed to agree with this dictum if taken as an abstract proposition, but I do not think that my critics can have subjected their view to calculation, the keystone without which the arch of speculation cannot be considered as secure. We know by experimental evidence that stellar space, and the matter filling it, are intensely cold, as proved by the winter-temperature of the polar regions; moreover water exposed even in the tropics to free radiation while insulated from the warm earth, freezes to a considerable thickness during a single night.

Let us suppose that the attenuated matter in space has a temperature of 160° on the absolute scale (being 114° below the freezing-point of water), and that it is 3000 times more rarefied than when it reaches by adiabatic comparison the solar photosphere. The rise of temperature due to this compression must be according to Rankine's well-known formula—

$$\tau_2 = \tau_1 \left(\frac{p_2}{p_1}\right)^{\frac{\gamma - 1}{\gamma}} = {}^{\cdot}29 = 1632^{\circ} \text{ absolute,}$$

and this would make the solar photosphere 1358° on the Centigrade scale; this temperature is quite inadequate to produce the solar luminosity, which must require one equalling, though probably not exceeding that of the electric arc.

But assuming a compression of the attenuated atmosphere up to the photospheric density (which according to most authorities does not exceed terrestrial atmospheric density), there would still remain the predicament that although a higher maximum temperature could be reached by compression, very little of the heat due to it could be spared for the purpose of radiation, without sacrificing the possibility of disposing of the refrigerated gases again into space. The refrigerated gases would obey the law of solar gravitation to a much greater extent than the heated incoming gases, and would certainly not pass away into space, unless acted upon by a considerable extraneous force. The mere passage of the solar orb through space at a majestic pace which does not exceed one quarter of our orbital velocity, could not possibly produce such a result, and even the fan action advocated in my paper would fail to work in opposition to a large determining influence of solar gravitation.

These conditions are entirely changed if we assume, in addition to adiabatic compression and re-expansion, a further source of heat such as is produced in combustion. One pound of hydrogen develops in burning about 60,000 heat units, and one pound of marsh gas 24,000 heat units; in my article upon this subject, published in the April number of the *Nineteenth Century*, I showed that if only one-twentieth portion of the gases streaming in upon the polar surfaces at the pace of 100 feet a second were combustible gases, they could produce an amount of heat more than sufficient to account for the entire solar radiation as determined by Herschel and Pouillet.

There is no reason for supposing that the instreaming gases would penetrate beyond the solar photosphere; they would flash into combustion whenever their temperature by adiabatic compression had reached the limit of spontaneous ignition without the presence of an igniting solid, a point which, if determined experimentally, would give a clue to the real vapour density of the photosphere; and after reaching the point of dissociation, combustion would continue in the measure of the abstraction of heat by radiation, thus producing a vast accumulation of igneous matter of comparatively low density. This would flow on, in the manner of a floating body, above the denser gases or vapours forming part of the permanent body of the sun, towards the equatorial regions, whence it would be propelled into space at a temperature exceeding to some extent that of the inflowing gases after compression, but before combustion, thus aiding, instead of retarding the supposed solar fan action.

The fan-action itself would be produced, no doubt, at the expense of solar rotation; but, in order to appreciate this retarding influence at its true value, it must be borne in mind that the flow of gases once established has only to be changed in direction; the velocity acquired by the inflowing gases is simply transferred to the outflowing current diminished by an amount of rotative force sufficient to cover frictional retardation. The very interesting leading article in last week's NATURE, regarding the solar observations in America, during the last eclipses, now published for the first time, furnishes an unexpected and most striking corroboration of the solar fan-action which I had ventured to put forward as a necessary consequence of solar rotation in space filled with attenuated matter.

I am well aware that my paper read before the Royal Society does scant justice to those who have devoted much time and ingenuity to the subject of solar physics, and that, moreover, many points of considerable interest connected with the views I advocate have been indicated only, instead of having been fully developed; but, on the whole, I thought it was better to present my views in mere outline before an audience well acquainted with our present information regarding solar physics, and with only half an hour's time at their disposal.

The elaboration of such a subject would necessitate the writing of a book rather than of a paper, and perhaps Dr. Sterry Hunt, who has already done so much to elucidate our present knowledge of solar physics, may be induced to extend his labours in this direction. C. W. SIEMENS

12, Queen Anne's Gate, Westminster, April 26

Silurian Fossils in the North-West Highlands

MY friend, Mr. Hudleston, in his letter on the Silurian fossils in the North-western Highlands, states very clearly a point which at the present time is of the highest importance to all students of the metamorphic rocks. If it can be proved that the Durness limestone, which contains undoubted lower Silurian fossils, is identical with the series in Western Sutherland and Ross, which Mr. Hudleston terms the quartzo-dolomitic, then the so-called "Newer Gneiss" must be more recent than it, and thus must be a metamorphosed representative of some part of the Silurian series. This would prove that very great regional metamorphism has taken place in the latter half of the Palæozoic period; and that its mineral condition will not aid us materially in determining the age of a rock which has once been stratified.

But is this identity proved; and is it certain that the Durness limestone is more ancient than the Newer Gneiss series? I have not myself had the opportunity of investigating the Durness region, though I have examined several specimens of its limestone; and from the condition of these and my knowledge of parallel cases, and of metamorphic rocks in general, do not hesitate to say that I should require very clear stratigraphical evidence before I could believe the Durness limestone to underlie the "Newer Gneiss." The former is no more metamorphic than are several of the Palæozoic limestones; the latter is always considerably, sometimes rather highly, metamorphosed. But in

the quartzo-dolomitic series the amount of metamorphism, though the materials are not favourable for its production, is considerable; and the rock has a general resemblance to some of the impure calcareous bands which are incorporated with true schists in the Alps.

Further, although our knowledge does not at present enable us to speak dogmatically on this point, the weight of evidence is, in my opinion, strongly against the probability of the Newer Gneiss series being altered Silurian rock. I would even go so far as to say that it is such as to throw the *onus probandi* on those who assert its (comparatively) modern date. For five or six years I have been working—I trust without prejudice—at the question of the age of metamorphic rocks, during which time I have visited typical districts in Cornwall, Wales, Scotland, and the Alps; and in every case have been driven to the same conclusion, namely, that wherever extensive regional metamorphism exists, the antiquity of the rocks is very great, so that they are probably anterior to the Cambrian period. I fully expect that when the Durness region is closely scrutinised, it will be found that this fossiliferous limestone is faulted down against the metamorphic series, exactly (for instance) as the so-called Devonian rocks of the Lizard are faulted against the "hornblende schists" of that district, and are a remnant, thus preserved, of a more modern and wide-spread series. Any geologist who would settle this point for us would be entitled to our gratitude, but to do it will require no ordinary conjunction of qualifications; for he must be a practised microscopist, a skilled worker in the field, and a man who cares for truth more than for the traditions of an office, or even his own preconceived opinions.

23, Denning Road, Hampstead T. G. BONNEY

WITH regard to Mr. Hudleston's letter on the above subject, published in NATURE (vol. xxv. p. 582), I am glad to say that I am still alive, and able to give a part, at least, of the desired evidence for connecting the Durness limestone with the rocks of Assynt and Erribol.

In the year 1858 I accompanied Sir Roderick Murchison, while on a geological tour in Sutherland. During our stay at Inchnadamff, one of our excursions led us together up the River Traligill. Opposite the place where the springs issue from the miniature limestone caverns, about two miles above the bridge, I espied the fossils in dispute—"orthoceratites"—partially weathered out of the dolomitic limestone from which the stream issues. So overjoyed was I, that I called Sir Roderick to my side by shouting "Eureka," as I was a little in advance of him, pointed out the fossils *in situ*, and after hammering them out of their bed, handed them to him. The circumstances of the achievement are indelibly impressed on my memory. As I only saw these fossils in the field, I am not able to tell to what species they belonged; but there can be no doubt of their nature, as in my attempt to hammer them out of the rock, one of them was broken in such a manner as to expose the septa and the siphuncle.

On a subsequent visit which I made to Sutherland, I had the good fortune to see the specimen of *Orthoceras* (*Cameroceras*) *Brongniartii* alluded to by Mr. Hudleston as "having been found in the upper quartz-rock of Erribol." It was in the possession of the finder, the late Mr. Clark, of Erribol House, who kindly allowed me to examine it. Mr. Clark accompanied me to the place, and pointed out the exact spot where he got the specimen—a little to the north-east of Erribol House.

CHAS. W. PEACH

30, Haddington Place, Edinburgh, April 24

The Magnetic Storms

THE magnetographs at the Kew Observatory were a little disturbed from about 11 p.m. of the 13th inst. to 7 p.m. of the 14th inst. During the 15th they were quiet, and remained so up to 11.45 p.m. of the 16th, when the disturbance began by an increase of the declination, an augmentation of the horizontal force, and a diminution of the vertical force. The movements of the declinometer became gradually more rapid after 2 a.m. on the 17th, whilst its oscillations extended farther and farther from its normal position principally in the direction of increased westerly declination.

From 4.30 to 9 a.m. the horizontal force had diminished so much that the trace frequently passed off the paper and the register was lost for a while. At this time the force must have been more than ·05 mm.mgrs. below its average value.

The minimum of vertical force occurred at 5.55 a.m., when it was about 0·07 units too low.

From 10 a.m. to noon of the 17th the motion of the declinometer was small, whilst the components of magnetic force were rapidly increasing in intensity, until at 0.15 p.m. both traces left the photographic sheet in the direction of augmented force; at this time the declination needle merely oscillated rapidly about its ordinary position.

The horizontal force instrument recommenced to record about 2 p.m., and the vertical force about 2.45 p.m.; afterwards the movements of all three gradually diminished, and at about 8 p.m. the disturbance had died out.

During the 18th and 19th the magnets remained unaffected, but at 3.45 a.m. of the 20th a second disturbance set in, commencing with a rapid increase of declination, the first swing of the magnet carrying it nearly a degree to the westward, whence it returned at 4.30 a.m. Its mean position was reached at 6 a.m., and then its oscillations became very rapid, and continued so until 2 p.m., after which hour they became less; but the effect of one disturbance lasted until 7.30 a.m. of the 21st.

Both forces were also simultaneously disturbed, but their movements were much more limited than on Monday, the extremes being in the horizontal ·04 mm.mgrs., and in the vertical 0·3 mm.mgrs. only. G. M. WHIPPLE

Kew Observatory, April 24

Colour Perception

WHILE working at dry-plate photography in a ruby light, I noticed that when any light-coloured article, such as the hand, was rapidly moved, it appeared of a brilliant greenish-blue, in which blue predominated, while, when slowly moved, it appeared of the same colour as the other objects in the room. Seeking for an explanation, led me to recognise a new fact about colour perception which may be of interest to your readers. The reason of the hand appearing blue when in rapid motion was because the continual use of the red light had fatigued that part of the retina responsive to it, and the light reflected from the hand impinging for a very short time on the retina, was not strong enough to excite the sensation of red, but was quite sufficient for blue, the nerves responding to this colour having been rendered acutely sensitive by complete rest. To test this hypothesis, I obtained some dark blue glass and applied it to the window of the dark room, removing the red. On repeating the experiment, the eye with its blue sense exhausted, saw rapidly-moving objects reddish. Now from this it is clear that it takes a longer time to cause a sensation in an exhausted than in a fresh organ. It also gives a direct proof of Helmholtz's suggestion, "that actual coloured light does not produce sensations of absolutely pure colour; that red, for instance, even when completely freed from all admixture of white light, still does not excite those nervous fibres alone which are sensitive to impressions of red, but also to a very slight degree those which are sensitive to green, and perhaps to a still smaller extent those which are sensitive to violet rays" ("Popular Scientific Lectures," first series, p. 223). These observations have led me to an explanation of a very curious phenomenon brought under my no ice by my friend, Mr. Napier Smith. When discs of paper on which black spaces have been marked, so that on rotation the eye receives impressions of black and white too rapidly to notice the pattern, but too slowly to combine into a neutral gray, the rotating card appears to be distinctly coloured, especially when it is looked at without keen attention, or as we may say passively. All colours may be seen, but red and blue were the most distinct to me. I at first thought that the colour might arise out of the paper and ink, the former being perhaps tinted with blue to whiten it in manufacture, and the latter probably a dark brown; but on looking several times at the solitary discs, and acquiring the power of looking passively the intensity of the colours could not be so accounted for. The true explanation is found, I believe, in the fact that the different colour organs require longer or shorter periods of excitation before responding to the stimulus, and that those which require the longest periods also retain the sensation longest. I have only made very rough trials, but they point to the fact that the eye responds quickest to red, so that the most rapid alternation will appear reddish, a little slower green will come in, and cause some indescribable colours, such as are seen in the polariscope, and lastly, when green and red are about equal, and producing white, blue will be seen. The blue is best seen with a slow

rotation, and a large amount of black, because the red and green impressions have time to die out, and the blue (the most persistent) remains alone, showing like a fine fluorescent layer overlying the disc. I have not at present the time, or I would attempt to find out the excitation-periods for the different colours by this method, and I believe that a finer mode of applying it might determine the real number of colour-sensations, and allow of a decision being arrived at between the theories of Young and Hering.

J. B. HANNAY

Dispersal of Freshwater Bivalves

IN the late Mr. Darwin's interesting contribution upon this subject (NATURE, vol. xxv. p. 529), mention is made of the fact that the newts in Mr. Norgate's aquarium "frequently have one foot caught by a small freshwater bivalve (*Cyclas cornea?*)." It is, perhaps, worth calling your readers' attention to a passage which occurs in Mr. Knapp's "Journal of a Naturalist" (2nd ed., p. 316), published in 1829, wherein, speaking of the newt, he says: "I have seen the boys in the spring of the year draw it up by their fishing lines, a very extraordinary figure, having a small shell-fish (*Tellina cornea*) attached to one or all of its feet; the toes of the newt having been accidentally introduced into the gaping shell, in its progress on the mud at the bottom of the pool, or decidedly put in for the purpose of seizure, when the animal inhabitant closed the valves and entrapped the toes. . . ."

This record, coupled with Mr. Norgate's statement in the article referred to, that "newts migrate at night from pond to pond, and can cross over obstacles which would be thought to be considerable," seems to point to the fact that the dispersal of bivalves by this means is more general than might at first be supposed.

FRANK J. ROWBOTHAM

The Horse in Motion

IN NATURE, vol. xxv. p. 591, you notice the publication of a work entitled "The Horse in Motion," by Dr. Stillman, and remark: "the following extract from Mr. Stanford's preface shows the exact part taken by each of those concerned in the investigations." Will you permit me to say, if the subsequently quoted "extract" from Mr. Stanford's preface is suffered to pass uncontradicted, it will do me a great injustice and irreparable injury. At the suggestion of a gentleman, now residing in San Francisco, Mr. Stanford asked me if it was possible to photograph a favourite horse of his at full speed. I invented the means employed, submitted the result to Mr. Stanford, and accomplished the work for his private gratification, without remuneration. I subsequently suggested, invented, and patented the more elaborate system of investigation, Mr. Stanford paying the actual necessary disbursements, *exclusive* of the value of my time, or my personal expenses. I patented the apparatus and copyrighted the resulting photographs for my own exclusive benefit. Upon the completion of the work Mr. Stanford presented me with the apparatus. Never having asked or received any payment for the photographs, other than as mentioned, I accepted this as a voluntary gift; the apparatus under my patents being worthless for use to any one but myself. These are the facts; and on the bases of these I am preparing to assert my rights.

449, Strand, W.C., April 26 J. MUYBRIDGE

DAILY WEATHER CHARTS IN THE NORTH ATLANTIC

WE append to this notice one of the most important statements hitherto issued from the Meteorological Office, from which it will be seen that the Meteorological Council have resolved to undertake the preparation of Daily Weather Charts of the North Atlantic for the thirteen months commencing next August. The scheme will, without doubt, call forth a co-operation equally hearty on the part of the owners, captains, and officers of sailing vessels and steamers which cross the Atlantic.

The figures of the wreck returns for the four years ending with June, 1880, show a striking diminution year by year, resulting as regards the gross totals in a steady reduction from 1805 in 1876-77 to 891 in 1879-80, or less than half the losses and casualties to shipping attributable to causes connected with the weather round the British coasts. No small part of this gratifying result may fairly be claimed as due to a gradual improvement in weather-forecasting and to a more intelligent attention now generally given to observational and instrumental indications of coming storms by those who man our fishing boats and coasting vessels. That much, however, yet remains to be done in some quarters by disseminating even the merest elementary notions of the subject was shown by the lamentable loss of life on October 14, 1881, on the morning of which day whole fleets of boats left the harbours and stood out to sea in the face of a barometer which had during the previous twelve hours gone down more than an inch.

The object aimed at is better and fuller information than is yet possessed as to the origin, development, and progressive movement of the storms which occur over the Atlantic. This information will not only immediately benefit seamen, but also promote the science of meteorology, and thus tend directly to the improvement of the weather forecasts and storm warnings issued to the British coasts by rendering easier and more certain the interpretation of the first indications of approaching changes noted at the western stations in Ireland and Scotland. The commencement of the observations in August next has been happily chosen, it being then that observations also begin at the international Arctic stations, which have been planted by different nationalities in Kamschatka, Siberia, Nova Zembla, northern Scandinavia, Greenland, and Arctic North America. There will thus be brought to bear on the examination of the Atlantic storms a fulness of information gathered from these floating and stationary observatories which will so largely extend the field of observation chiefly on what we may call the weather-side of Europe, not hitherto attainable, which cannot but be productive of solid advantages to our seafaring population, and to all whose material interests may be benefited by a knowledge beforehand of weather changes.

The Meteorological Council, however, act wisely in warning against being over-sanguine as to the importance of the results to be obtained by the inquiry they are about to undertake. No decidedly great step is likely to be taken in the improvement of weather forecasting, as regards time and precision, until either of two things be done, namely, till either a cable be laid to Newfoundland, *viâ* Faro, Iceland, and Greenland, or till science has taught us to moor a ship 700 or 800 miles out in the Atlantic, as a floating meteorological observatory, connected by cable with the west of Ireland.

The observations of the temperature of the surface-water of the Atlantic it is proposed to make from the equator northwards, is one of the most important features of the investigation. By these observations, continued widely and uninterruptedly over a space of thirteen months, the great practical question of the bearing of the temperature of the surface-water of the Atlantic, particularly between lat. 30° and 50°, on the character of coming seasons, can be investigated, and different theories on the subject be put to the proof. To take an example—it has been inquired (NATURE, vol. xxi. p. 142) whether, when the temperature of the Atlantic to the south-west of the British Islands, is decidedly above the normal temperature of the season, it does not follow, owing to the larger evaporation and other resulting effects, that Atlantic storms take a more southerly course than usual in their passage across Europe. If the storms of any particular winter pursue an easterly course to southwards, of the British Islands, that winter will, like the winter of 1870-71, be a severe one; but if, on the other hand, these storms pursue a course to the northward, the winter will partake more or less of the mildness of the winter we have just passed through. Since the character of the season thus depends on the line followed by the atmospheric disturbances which occur, it results that if the track of the storms be dependent on the amount of evaporation from

he Atlantic, the general character of the weather of any coming season may be foretold.

The following statement has been issued from the Meteorological Office, London :—

"The Meteorological Council propose to undertake the preparation of daily weather charts of the North Atlantic Ocean for the thirteen months beginning on August 1 in he present year, and ending on August 31, 1883.

"It is well known that the changes of weather which we experience are in general caused by atmospheric disturbances, which travel more or less rapidly, and undergo more or less modification during their progress. By far the larger number of the disturbances which visit the British Islands arrive on our shores from the Atlantic Ocean, and our earliest information as to any impending change is consequently derived from telegraphic reports from the Atlantic coasts, especially from the British stations at Stornoway, Mullaghmore, and Valentia, and occasionally from the Continental observatories at Rochfort and Corunna. But of the origin and previous history of these systems we have no sufficient knowledge, except in a few isolated cases.

"The Meteorological Council believe that any systematic information which can be obtained as to the origin development, and laws of motion of the atmospheric disturbances which occur over the Atlantic Ocean would promote the science of meteorology and be of immediate benefit to seamen traversing the Atlantic Ocean, and would tend directly to the improvement of the forecasts and storm warnings issued to the British coasts, by rendering the interpretation of the first indications of approaching changes observed at the western meteorological stations more easy and certain.

"The importance of a systematic study of the weather of the North Atlantic Ocean has long been recognised, and series of daily synoptic charts, more or less resembling those now in contemplation, have been prepared at various times, not only by the Meteorological Office, but also by the Association Scientifique de France under the guidance of Leverrier, by Capt. Hoffmeyer, of the Danish Meteorological Institute, by the Deutsche Seewarte, at Hamburg, and (as a part of a wider plan) by the Chief Signal Office of the United States. But none of these charts, however valuable in other respects, supply adequate materials for a satisfactory discussion of Atlantic weather, chiefly on account of the small number of the observations upon which they are founded as compared with the magnitude of the area over which they are spread.

"Evidence of the interest attaching to the connection between English and Atlantic weather is afforded by the efforts which have been made during the last few years by the proprietors of the *New York Herald* to transmit to England from America telegraphic predictions of approaching disturbances, which (it is presumed) are founded on the reports of vessels arriving in America from the Atlantic Ocean. Reports such as these from a large number of vessels would be of great value ; but the predictions taken by themselves cannot be utilised in a scientific investigation of weather.

"The Meteorological Council gratefully acknowledge the large measure of invaluable help which they have hitherto received from seamen and the shipping interest generally. But as the object now proposed can only be achieved by the voluntary cooperation of an increased number of observers, they feel justified in making a special appeal for assistance to the owners, captains, and officers of ships, and especially to the great companies whose steamers ply between this country and America. In a science which, like meteorology, is still in its infancy, every advance is attended with great difficulties, and the Council are well aware that it would be easy to be too sanguine as to the importance of the results to be obtained by the inquiry which they are about to undertake. But having regard to the loss of life and property occasioned by storms on our coasts,[1] they feel confident that their proposal will commend itself to the public generally, and will insure the active co-operation of those classes of the community for whose benefit it is primarily intended.

"It is proposed to ask for observations of the barometer, of open air and sea-surface temperatures, wind (direction and force) and weather at 8 a.m. and noon each day, with the position of the ship at noon.

"Forms for recording the observations will be supplied by the Meteorological Office, 116, Victoria Street, London, S.W., on application to the Marine Superintendent."

PISCICULTURE IN THE EDINBURGH FISHERY EXHIBITION

IT was a happy thought of the promoters of the Fishery Exhibition to secure the Aquarium for the use of their visitors. Although it is on a small scale, it adds largely to the amenities of the exposition, and must prove a novel sight to many inland visitors. At most of the French fishery exhibitions, and at Arcachon in particular, an aquarium proved one of the greatest of the many attractions provided for the thousands who came to the châlet which contained the general exhibits. It must be confessed, however, that the French made more use of their aquarium than the directors of the Edinburgh Exhibition seem inclined to do—we miss some of the wonders of the deep in the shape of "fancy fishes," which we think might have been included in the present "show." There is one exhibit, however, which helps to make up for numerous deficiencies; we allude to entry No. 23 in the Catalogue, which is as follows :—

> Mu-ynski, Constantine, St, Petersburg.
> 10,000 live fry of the species *Coregonus Bacri* (Sigue), sent from St. Petersburg to this Exhibition (see in Aquarium).

There is much more in this simple entry than all at once meets the mind's eye. The fact of these young fish being in Edinburgh signifies a piscicultural feat of great importance. That impregnated fish eggs can be, and have been forwarded to great distances we know, but, as regards young fish, it has hitherto been a pretty general opinion that it would not be safe to send them a journey that would occupy a longer period than from twenty to thirty hours. Now we are disillusioned as to that : in the Waverley Hall, at Edinburgh, we see ten thousand young fish in a healthy and lively state, that have come from a place which is two thousand miles distant. The problem of supplying these young fish with air during their long journey was solved in a very simple way, a glass tube of small diameter being inserted in the cork, whilst the shape of the great bottle (a carboy ?) in which the fish travelled, insured the constant motion of the water. At all events, in whatever way this feat was accomplished, the young fish arrived in safety, the percentage of deaths being of no consequence—not 3 per cent., we believe. In connection with this Russian gift, a vexed question has arisen at the Exhibition. Put in simple form, it is, Now that we have got these fish, what use can we make of them ? It is quite clear that we cannot return them to Russia, and whether it would be safe to add them to the stock of any of our lochs has given rise to much controversy. It was first of all proposed to place them in Loch-

[1] The wreck return published by the Board of Trade for the year ending June 30, 1880 (C. 2506) (the last published), gives on p. 20 the following list of casualties on our coasts attributable to causes connected with the weather :—

		Total Losses.	Serious Casualties.	Minor Casualties.	Total.	
1879-80	Founderings ...	16 ...	0 ...	0 ...	16	
	Strandings ...	81 ...	108 ...	178 ...	365	
	Other causes...	0 ...	105 ...	405 ...	510	
Totals for	1879-80 ...	97 ...	213 ...	581 ...	891	gross total
,,	1878-79 ...	121 ...	227 ...	761 ...	1,109	,,
,,	1877-78 ...	138 ...	289 ...	1,002 ...	1,429	,,
,,	1876-77 ...	180 ..	367 ...	1,258 ...	1,805	,,

leven, but, at such a prospect, anglers have taken alarm, fearful lest the newcomers, when they have attained their full size, may devour the "finest trout in the world"—*Salmo levensis*—a fish which has been compared with the *Fario lemanus* of the Lake of Geneva; and in consequence of this opposition of the anglers, the Coregoni will probably find a home in Duddingston Loch, near Edinburgh, which, however, is much too small for such a large number of fish. Why not place the Russians in some of the lakes of Scotland, which already contain similar fish, in the town loch of Lochmaben, for instance, the home of the *Vendace*, or in Lochlomond, where may be seen the *Powan?* Or some hundreds of them might be sent to Loch Neagh in Ireland, which contains the *Pollan.* Hoping that a suitable home may be found for these finny treasures, it will be interesting to note their future growth, to ascertain when they breed, how long it is till the spawn comes to life, and at what age the fish become reproductive.

The Edinburgh Exhibition is undoubtedly indebted to Sir James Gibson Maitland for a good show of young fish; "live Salmonidæ artificially reared," at his extensive fishery of Howietoun near Stirling, where there is accommodation for the hatching of many millions of fish eggs. Sir James has directed his attention chiefly to the breeding of the trout of Lochleven, in which he has been exceedingly successful, also salmon, and the common trout of the country, as well as the *Salmo Fontanalis* of America. Howietoun is a commercial fishery, from which supplies of fertilised eggs and "eyed ova" of the fishes named may be procured at a given price. The proprietor has an exhibit in the Waverley Hall (No. 168 in Catalogue) of hatching and other apparatus incidental to the piscicultural operations carried on at his fishery. It has been found in the course of the routine work at Howietoun, that it is possible to transport eyed-ova with perfect safety to any part of the United Kingdom, and apparatus are shown suitable for the transport of large trout, providing for the automatic aëration of the water by means of a wedge of perforated zinc in the lid; there is also shown a "packing-case for transport of ova for long distances, with air chamber, ice tray, and ventilation of ova." It may interest persons interested in Pisciculture to know that the chief food supplied to the young fishes at Howietown is horseflesh, three or four horses being used every week; the Lochleven trout are fed on clams procured from the Firth of Forth, and Sir James Maitland, we believe, is also growing snails for the purpose of feeding the young fish.

It may, we think, be taken for granted that the piscatorial feat which we have recorded, the transport of the fry from St. Petersburg to Edinburgh will give such a decided fillip to piscatorial operations of all kinds as may prove beneficial; there are many barren sheets of water which might be advantageously populated with some one or other of the many species of the finny tribe, whilst proprietors of lakes or rivers which are tending to barrenness cannot do better than restock them with fry of the far-famed Lochleven trout, or of the *S. fontanalis* of America, the latter for running streams, the former for sheets of water of some magnitude.

THE EDINBURGH CHAIR OF NATURAL HISTORY

PROF. RAY LANKESTER, who has resigned the Edinburgh Chair of Natural History, which he accepted a fortnight ago, has requested us to publish the following statement:—

I have elsewhere stated the reasons which have led me, with very great regret and after anxious consideration, to withdraw from the honourable position of Regius Professor in the Edinburgh University, before actually ntering upon the duties of the office. They, briefly tated, amount to this—that I had formed a mistaken estimate as to the extent to which the Professor's time would be occupied, the appliances at his disposal, and the security of his emoluments. For this mistake I am anxious to state that I accept the painful responsibility. At the same time I desire to say to those to whose support and interest in the matter I have been and remain so deeply indebted, that the warmth of the contest, which has occasioned no small expenditure of time and trouble to them—expenditure which I must ever remember with gratitude, and unfortunately also with deep regret—explains and, I hope, may be considered as excusing the tardiness of my arrival at a correct estimate of the desirability of exchanging my position in London for that in Edinburgh.

I have also to explain that it was solely a desire to give the least inconvenience possible to the authorities, which led me to communicate my resignation, and the reasons for it, to those whom it affected, *without any delay.* It has been pointed out to me, that my action may have appeared abrupt, and wanting in consideration for others. I should wish, on the other hand, to say that the reflection that my resignation must cause considerable disappointment, and even annoyance, to those whom I had most reason to spare such feeling, led me to hesitate in taking action, until the necessity for making arrangements both in Edinburgh and in London, was so pressing, as to make the immediate statement of my intentions, to all persons concerned, imperative.

Lastly, I should wish to state that I should find my regret for the present occurrence greatly increased, were it supposed that I do not recognise the dignity and importance of the University of Edinburgh, and the high position of its professors. I can only say, that I am sincerely sorry that circumstances should render it, in my opinion, desirable to forego the honour of entering upon that association with the University which was contemplated, and of working with colleagues for whom I, in common with all men of science, have the greatest respect and esteem, and amongst whom I am proud to reckon personal friends.

E. RAY LANKESTER

ON THE RELATIVE RESISTANCES OF LAND AND WATER TO WIND CURRENTS

IN 1878 I received a grant from the Government Research Fund for the purpose of ascertaining the law of variation of wind velocities at different heights: and I found that the curves traced out by the velocities in relation to the heights were most nearly represented by the formula $V = v \sqrt{\frac{H + 72}{h + 72}}$, where H and h represent respectively the heights in feet of the high and low level stations above the ground, and V and v the respective velocities at those levels.

I have since then been making observations with the view of ascertaining the relative resistance of land and water to the aërial currents. These observations are very far from being complete, but I give the following results in the meantime, as they may be interesting.

	Sand.	Water.		
6″ waves ...	12·8	13·8	miles per hour	= 1 : 1·08
6″ ,, ...	13·65	14·375	,, ,,	= 1 : 1·06
3″ ,, ...	7·96	9·19	,, ,,	= 1 : 1·155
	Grass.	Water.		
9″ ,, ...	8·4	10·7	,, ,,	= 1 : 1·274
3″ ,, ...	10·13	14·75	,, ,,	= 1 : 1·456

The velocities given are the means of observations taken every five minutes for about an hour.

From this it will be seen that the resistance is least for water, somewhat greater for smooth sand, and greater still for grass. Further observations are not only required on this subject, but also on the velocity of the wind over the water in relation to the height of the waves.

Edinburgh, April 18 THOMAS STEVENSON

ILLUSTRATIONS OF NEW OR RARE ANIMALS IN THE ZOOLOGICAL SOCIETY'S LIVING COLLECTION[1]

VII.

17. HARDWICKE'S CIVET-CAT (*Hemigalea Hardwickii*).—The Viverridæ, or Civet-cats, form a well-marked family of carnivorous mammals peculiar to the tropics of the Old World, and mostly confined to Southern Asia and Africa, though one or two of them occur in the southern parts of Europe. One of the finest and largest of them is the True Civet-cat (*Viverra civetta*), from the anal glands of which the old-fashioned perfume known as civet is extracted, and the Genets, Ichneumons, and Mungooses are well-known members of the same family, examples of which are always to be seen in the Zoological Society's Collection.

Amongst the rarer and less familiar forms of the Viverrine groups is the very curiously-marked animal which we now figure (Fig. 17) from a specimen received by the Society in October, last year. Hardwicke's Civet, though first described by Dr. Gray so long ago as 1830, is a very scarce and little-known species, and the present example is believed to be the first of its kind ever brought alive to this country. In 1840 Müller and Schlegel gave an excellent figure and desciption of this animal, under the name of *Viverra boiei*, in their great work upon the Natural History of the colonial possessions of the Netherlands. Their specimen was obtained in South-Eastern Borneo by Herr Henrici, and sent alive to the Gardens of the Zoological Society of Amsterdam. Hence, after its death, it was transferred to the National Museum of Leyden. Müller adds that he never met with this Civet-cat himself during his extensive travels in the Eastern Archipelago, and had received no information as to its habits.

Hardwicke's Civet-cat was also figured and described by Eydoux and Souleyet in the "Zoology" of the voyage of the *Bonite* in 1841, under the name *Hemigale zebra*, but again without any information as to its habits, not even the locality of their specimen being stated.

So far as has been ascertained from the Zoological

FIG. 17.—Hardwicke's Civet-cat.

Society's living specimen, this animal is excessivly shy and retiring in disposition, and apparently does not leave its retreat voluntarily except at night. When handled, it ejects a highly acrid and skunk-like secretion from its anal glands. The length of the body in the example figured is about 24 inches, and that of the tail about 18 inches.

18. The Warty-faced Honey-Eater (*Meliphaga phrygia*).—No group of animals is more characteristic of the peculiar fauna of Australia than the great family of Honey-Eaters (Meliphagidæ), of which upwards of sixty species, belonging to many different genera, are distributed throughout the length and breadth of that Continent. But although the Honey-eaters are so common in Australia, and there is an extensive importation of living birds from Sydney and other Australian ports every year into this country, very few of the Meliphagidæ have yet reached Europe alive. Almost the only Honey-eater habitually imported living—is the so-called Parson-bird (*Prosthemadera Novæ Zeelandiæ*) of New Zealand, which is much valued in that colony as a cage-bird, and thus finds its way not unfrequently to London. The fact is, that the organisation of the Honey-eaters, being adapted for an active and wandering life, in perpetual search of the nectar of the flowering-trees which their pencilled tongue so admirably fits them to collect, does not render them very suitable subjects for captivity, and it is only recently that means have been found to preserve these birds alive and in good health in cages. It has thus happened that almost the only one of the vast tribe of Australian Honey-eaters that has been exhibited in the Zoological Society's aviaries is the present species, which we now figure (Fig. 18) from four examples lately received from New South Wales.

In his great work on the "Birds of Australia," Mr. Gould tells us that the Warty-faced Honey-eater is not only one of the handsomest of its tribe, but also one of the most beautiful birds inhabiting Australia, the strongly contrasted tints of its black and yellow plumage rendering it a most conspicuous and pleasing object, particularly during flight.

Although very generally distributed, its presence ap-

[1] Continued from p. 393.

pears to be dependent upon the state of the *Eucalypti*, upon the blossoms of which it mainly depends for subsistence; it is consequently only to be found in any particular locality during the season that those trees are in blossom. It generally resorts to the loftiest and most fully-flowered tree, where it frequently reigns supreme, buffeting and driving every other bird away from its immediate neighbourhood; it is, in fact, most pugnacious, evincing particular hostility to the smaller *Meliphagidæ*, and even to others of its own species that may venture to approach the trees upon which two or three have taken their stations.

Mr. Gould further tells us that the nest of the honey-eater, which is usually constructed on the overhanging branch of a *Eucalyptus*, is round, cup-shaped, about five inches in diameter, composed of fine grasses, and lined with a little wool and hair. The eggs are two in number, of a deep yellowish buff, marked all over with indistinct spots and irregular blotches of chestnut-red and dull purplish grey, particularly at the larger end, where they frequently form a zone; they are eleven lines long, by eight lines and a half broad.

The stomachs of the specimens killed by Mr. Gould were entirely filled with honey; insects, however, he says, doubtless form a considerable portion of their diet.

The examples of the species now in the Zoological Society's Gardens are four in number, and apparently form two pairs, but there is little or no external difference between the sexes. They are lodged in one of the large cages at the back of the "Insect-house," and show every sign of good health. It is even hoped that they may nest and breed in captivity.

19. The Lobed Musk-duck (*Biziura lobata*).—Water-fowl have always formed a favourite portion of the Zoological Society's living collection, and a considerable number of species of swans, ducks, and geese of various sorts have from time to time reproduced their kind in the ponds and inclosures in the north garden. Many of these have been introduced by the Society for the first time into Europe, and have thence found their way into the other Gardens on the continent.

Owing to the great success which has attended their efforts in these directions, the Society are always specially anxious to add new species to this branch of their living series, and it is with great satisfaction that every new addition to the already long list of "acclimatisable" Anatidæ is announced in their journals. The species which is now portrayed (Fig. 19) is certainly one of the most remarkable that they have yet procured, and although perhaps not likely to be "acclimatised" at present, is well worth examination as being remarkable even amongst Australian animals, for several very abnormal features in its structure. Mr. Gould, to whose great works every writer upon the mammals and birds of Australia must not fail to turn for information, tells us that the Musk-duck belongs to a genus of which only a single species is known, and which is singularly different from every other member of the *Anatidæ;* so different, in fact, that although like Bonaparte, he has placed it next to *Erismatura*, he believes its alliance to that form is but a seeming one. "There is something about this extraordinary bird," Mr. Gould continues, "which reminds one of the cormorants"; yet no ornithologist

Fig. 18.—Warty-faced Honey Eater.

Fig. 19.—The Lobed Musk Duck.

would, he presumes, associate it with those birds. "Like many other of these antipodean forms, it must be regarded as an anomaly; it is, in fact, a *Biziura*, and nothing more, for it stands alone."

The Musk-duck has a lengthened, stiff, and leather-like appendage hanging from the under surface of the bill, and is the only member of the family which possesses this singular structure. Its lengthened tail, composed of twenty-four narrowed and stiffened feathers, is, no doubt, most serviceable to it in swimming and diving. The female does not carry the chin-lobe, and is very much smaller than the male bird.

The Musk-duck is widely distributed on the Australian Continent, and also inhabits Tasmania. As Mr. Gould tells us, it frequents the bays and inlets of the sea, the upper parts of rivers, lakes, and secluded pools. "More than a pair are rarely seen at one time; often a solitary individual takes up its abode in some favourite pool, where it lives a life of complete seclusion, depending for its food and for its preservation from danger upon its powers of diving rather than upon those of flying. It is very difficult to shoot, as it dives instantly a gun is fired, so that the shot has hardly time to reach it.

The male examples of this curious duck were purchased by the Zoological Society on February 8 last. They were not in good condition when received, and though the utmost care was taken of them, one of them is since dead. The other may be seen in one of the tanks at the end of the Fish-house.

THE LIFE-HISTORY OF THE EEL

ALL persons interested in the mystery that until quite recently hung over the life-history of the eel, will find themselves under great obligations to W. Brown Goode for the very able and exhaustive account which he has quite recently published on this subject in the *Bulletin* of the United States Fish Commission, based upon the scholarly work of Jacoby, and from which we abstract the following. The number of species described by some authors is very large. Dr. Günther would seem to recognise only about twenty-five. Dareste still further reduces the number, making but four species in the genus Anguilla. *A. vulgaris*, occurring throughout the northern hemisphere in the New and in the Old World, *A. mowa* and *A. marmorata* in the Indian Ocean, and *A. megalostoma* in Oceania, and he further declares that even between these four the boundaries are not clearly defined. The habits of the eel are still not quite understood. So far as is known, it is the only fish, the young of which ascend from the sea to attain an imperfect maturity, and return to the sea to deposit their spawn. The economical value of the eel as a food fish has been now well established, and they easily admit of being artificially introduced into lakes and rivers. The reproduction of the eel has from the days of Aristotle given rise to the most wonderful conjectures and assertions. Leaving out of question such old theories as that the eels are generated from dew, slime, horsehair, and from the skins of old eels, it has been a matter of dispute for centuries whether the eel is an oviparous or a viviparous animal. The reproduction of the eel was a mystery to the learned Greeks. While they knew that other fishes deposited their eggs, no discovery of the eggs of eels was ever made by them. The Greek poets solved the mystery in an off-handed way; for as they were in the habit of assigning to Jupiter the paternity of all children not claimed by earthly fathers, so they attributed the progenitorship of the eels to the same Jove.

With the revival of the study of the natural sciences in the sixteenth century, we find that investigators turned their attention with great ardour to this special subject, and such renowned investigators as Aldrovandi, Rondelet, and Salviani published elaborate treatises on the generation of the eel; and they were followed by Albertus Magnus, Leuwenhoek, Elsner, Redi, and Fahlberg.

It was in the eighteenth century that for the first time the roe of the female eel was discovered. A surgeon of Comacchio, named Sancassini, in 1707, sent the ovaries, as he thought, of an eel, to the celebrated naturalist Valisneri, who sent an account thereof to the Academy of Bologna. Prof. Valsalva appears to have doubted the correctness of this discovery. The discussion continued. Pietro Molinelli offered a large reward for a gravid eel. In 1777 an eel presenting the same appearance as the one described by Valisneri was sent to Prof. Monti, who, being indisposed for the investigation, gave it over to a set of his favourite pupils, among whom was Camillo Galvani. These students pronounced the anatomical appearance to be the same as described by Valisneri, and the specimen was sent to Prof. Mondini for his opinion, which was published in the Bologna Academy's *Transactions*, to the effect that the ovary described by Valisneri was only the swimming bladder in a diseased condition. But in connection with this opinion Mondini gave and illustrated by magnificent plates a good description, and demonstrations of the true ovaries of the eel as found by himself. This classical work of Mondini has been often overlooked. Later, but quite independently of Mondini, the ovary of the eel was discovered by O. F. Müller Spallanzani's investigations in 1792 threw doubts upon the discoveries of Mondini and O. F. Müller, so that when Prof. Rathke in 1824 described the ovaries of the eel as two cuff and collar-shaped organs on both sides of the backbone, he was everywhere in Germany (and is to a large extent to the present day) regarded as the discoverer. The first picture of the ovary, after that of Mondini, and the first plate of the microscopical appearance of the egg of the eel was published in a dissertation by Hohnbaum Hornschuch in 1842, and the question of the ovary of the eel may be regarded as definitely settled by the publication by Rathke, in 1853, of a description of a gravid female eel, the first and only specimen of such which had come up to that time into the hands of an investigator.

The search after the roe in the eel was of much later date. In 1842 and up to 1872 the researches of several observers were unrewarded with success.

Of the various mistakes made in this investigation Dr. Jacoby gives us an interesting account. In the meanwhile the late Dr. Syrski, the Director of the Museum of Natural History at Trieste, had undertaken, at the request of the marine officials at Trieste, to determine t..e spawning-time of the fishes of this region, and he devoted a good deal of his attention to the *smaller* eels. On November 29, 1873, Dr. Syrski found in an eel, now preserved in the Museum at Trieste, which was fifteen inches long, a completely new organ, which had never before been seen within an eel by any former investigator, although tens of thousands of eels had been zealously studied. Syrski published his discovery in the *Proceedings* of the Vienna Academy for April, 1874, and, according to all the researches up to this time made, there would seem the highest probability that this organ of Syrski is actually the long sought, but immature male organ. The investigation cannot be said to be complete until the presence of spermatozoa is determined; but the recent discovery of such in the similar spermaries of the conger eel, by Dr. Hermes, of Berlin, is a strong confirmation. The eels with the Syrskian organ are smaller than the females, and are to be found only in the sea and brackish water. They have a short and sharply-pointed snout. Their dorsal fin is less broad, and not so high as in the females.

This discovery of Syrski drew attention anew to the solution of the eel problem. Among others, the German Fischerei-Verein in Berlin offered a reward of 50 marks to the person who should first find a gravid eel sufficiently developed to satisfy Prof. Virchow of the fact. Herr

Dallmer, of Schleswig, Inspector of Fisheries in that province, offered to transmit communications to Berlin, and in 1878 he published an interesting report of the proceedings. Quite beyond all his expectations, his wishes had been made known by the press to all the regions between the Rhine and the Weichsel, and from the Alps to the sea. The number of letters which he received at first gratified him, next surprised him, and finally so terrified him, that at last he was obliged to refuse to attend to communications. Prof. Virchow also received an incredible amount of letters from all parts of Germany, and in a little time Prof. Virchow too was compelled to publish a notice urgently requesting no more communications to be sent to him, for that he did not know what to do with those he had got.

Although a few links are still wanting to complete the chain of the life-history of the eel, it may be most safely assumed that the eel lays its eggs like the majority of fishes, and further, that, like the lamprey, it only spawns once and then dies. It would also seem most probable that the spawning takes place only in the sea. Eels placed in land-locked ponds, though they increase in size, never, it is well known, increase in numbers. The most important problem still to be solved is, do the male eels ever leave the sea and enter fresh water. Dr. Jacoby found male eels in the lagoons of Commachio, where the water is brackish, and these must have ascended in the mounting as fry, and then, probably, at the approach of sexual maturity, descended with the females to the sea. Dr. Hermes found some 11 per cent. of males among eels taken at Willenberg on the Elbe coast, 120 miles from the German Ocean, and no males whatever at Havelberg, twenty or thirty miles higher up the stream. Thus the numerical percentage of males to females was in proportion to the nearness to the sea.

In connection with this subject the valuable observations of Dr. Hermes on the conger, made during 1881, in the tanks of the Berlin Aquarium, may well be alluded to. Dr. Hermes found the reproductive organ in the conger very similar to those as now supposed to exist in the common eel, and in the comparison of size the relations remain the same. The male congers are much smaller than the females.

Space will not allow us to do more than refer to the journey of Dr. Jacoby in 1877, from Trieste, by way of Ravenna, to Commachio; nor to his account of the sterile females of a delicious flavour, known as Pasciuti; but we would suggest that no more satisfactory or useful work could be translated than Jacoby's "History of the Eel: with an Account of the Celebrated Eel Fishery of Commachio;" which was issued from the Berlin firm of August Herschwald, not very long ago.

SIR HENRY COLE, K.C.B.

HENRY COLE, the eldest son of Captain Henry Robert Cole, was born at Bath, on July 15, 1808. On January 12, 1817, he was admitted to Christ's Hospital, where he remained until April 9, 1823. There had been some idea of sending him into the Church, but it was abandoned, and the day after he left school he commenced his career in the public service, under Mr. Cohen, afterwards Sir Francis Palgrave. His leisure at this time was spent in botanising in the neighbourhood of London; drawing under the tuition of David Cox, and contributing to the public journals. On December 28, 1833, he married his cousin, Miss Marian Bond. The public records were endangered by the burning of the Houses of Parliament in the following year. Cole worked vigorously for their preservation at the time, and was for long afterwards engaged in their arrangement. In spite of these heavy labours he had found time to commence a work on light, shade, and colour, when the prosperity of the young manager was abruptly interrupted by his summary dismissal from the Augmentation Office on December 5, 1835. He had ventured to call in question, and that in the singularly emphatic manner which characterised him through life, the competency of his official superiors, and had indicated the gross mismanagement which then obtained. It was believed that Mr. Cole's charges were unfounded, but a Committee of the House of Commons fully justified his action. He was at once reinstated in his office and advanced to be assistant keeper of the Records. At this period of his career he did yeoman's service to the cause of postal reform, and found leisure to issue, under the *nom de plume* of Felix Summerly, a series of Guide Books to Hampton Court, Canterbury, Westminster Abbey, Temple Church, the National Gallery, Free Picture Galleries, Day Excursions, Holidays spent in and near London, as well as to the various lines of Railway as they sprang into existence. Besides these he published his long-deferred "Light, Shade, and Colour," and it is one of the features of his life that he uniformly dropped a scheme which was for the time abortive, and uniformly took it up again at the relinquished point when a more propitious time arrived. He also wrote numerous works for the amusement and instruction of children in whose service he enlisted some of the most eminent artists then living. He found employment for ladies in engraving his illustrations, thus making an early attempt to solve the difficult problem of woman's work.

About this time his artistic sensibilities were shocked at the native hideousness of British manufactures, and he became a member of the Society of Arts, into the fossilised bones of which he soon instilled a new vigour. Still it was with the greatest difficulty that the leading manufacturers could be induced to co-operate. A prize competition was projected, but they dreaded to permit their names to appear, so jealous were the retail traders of their own interests. At last the show of Art Manufactures came off, and Henry Cole gained the silver medal of the Society of Arts for his "Felix Summerly" tea service. This success he followed up by a plan for the regeneration of British art applied to industry by the establishment of quinquennial exhibitions of British manufactures to commence in 1851. He commenced the issue of the *Journal of Design* to disseminate his views, and to gain information he visited the exhibition held in France in 1849. On his return he submitted his draft project to Prince Albert, by whom it was favourably received; the design grew, and expanded from a projected national exhibition to be held on the then waste ground of Leicester Square into the Great Exhibition of All Nations in Hyde Park. The conception was novel, and friends were timorous—fights hard and frequent enough to have subdued a less resolute will fell to Cole's lot—but by dint of a bull-dog refusal to be beaten, he ultimately assured the successful issue of the vast undertaking. The results gained by that success surround us on every hand in the improved taste of the country, as well in important as trivial matters. This is apparent when the manufactures of to-day are compared with those endured by our fathers.

At the conclusion of the Exhibition he had the satisfaction to see the purchase of a small collection of objects chiefly from the Indian court. These, with the drawings from the schools of design, were lodged in Marlborough House as the nucleus of a possible national art repository, which has been since realised in the South Kensington Museum.

Mr. Cole was, in 1852, appointed General Superintendent of the Department of Practical Art, which was succeeded in the following year by the Department of Science and Art, and it devolved upon him to reorganise the desultory instruction which had up to that time been afforded by the Schools of Design. How ably he, with the invaluable assistance of Mr. Richard Redgrave, R.A.,

accomplished this work, is testified by the present condition of the Schools of Art.

He was the British Commissioner for the Exposition Universelle at Paris in 1855, and on his return to England, Marlborough House being required for the use of the Prince of Wales, the collections in his custody were removed to those iron buildings which had been erected by the Commissioners of 1851, and which were commonly known by the alliterative sobriquet of the Brompton Boilers. Here, in spite of opposition and obloquy, he gradually secured the perfection of the collections, notably by the purchase after long and difficult negotiation of the Soulage collection in 1857, and the provision of adequate buildings for their reception. But he did not rest satisfied with success; as early as the year 1858 he projected a vast chorus hall, realised in the Royal Albert Hall in 1871, and the Horticultural Gardens opened in 1862. A Select Committee of the House of Commons on South Kensington, which it was thought by many would reveal a tissue of "jobbery," converted several of his opponents to a sense of the ability and integrity with which he had administered its affairs.

Though styled the Department of Science and Art, little had been done for the propagation of science prior to the year 1859. The question then arose as to the propriety of doing something to justify the title or of dropping it altogether. Mr. Cole's sympathies lay rather with the art side of the question, but he was sufficiently alive to the importance of science to urge upon the Lords of the Committee of Council the formation of a proper system of science instruction. He had the instinct which selects the right man for the right place, and found in Colonel Donnelly a colleague who ably worked out the details of that science teaching which is now going on in 1500 science schools where over 59,000 students are under instruction.

Mr. Cole next initiated the Exhibition of 1862, to the executive of which he acted throughout as general adviser, The provision of funds for the erection of the Royal Albert Hall was the next pressing question, and these General Grey, the Queen's private secretary, and he, raised by a system of subscriptions for boxes and sittings.

It was determined that South Kensington should not enjoy a monopoly of the national collections, and in 1866 the East London Museum in Bethnal Green was projected. In the following year Mr. Cole was again Commissioner for Great Britain at the Paris Exhibition, a novel feature which he introduced there being a collection of all the newspapers published in the United Kingdom. It was whilst in Paris that Sir Joseph Whitworth first discussed with him his desire to assist mechanical science by the formation of those scholarships which have since promoted the scientific education of the artisan, and rendered it possible for a young man of distinguished ability to raise himself to a position which he could scarcely else hope to attain.

Though informed in 1870 by his medical adviser of the impaired action of his heart, he did not relax his active labours; not only did he, in the following year control the first of the Annual International Exhibitions, but found time to busy himself with the disposal of the sewage of our great towns. In 1872 he received the Gold Albert Medal from the Society of Arts. After 50 years of public service, Mr. Cole retired on a full pension specially awarded by the Treasury in May, 1873. But his retirement from the South Kensington Museum certainly meant no abandonment of work. Mr. Cole founded the School for Cookery; edited an edition of T. Love Peacock's works; projected and worked out many details of a universal catalogue of printed books; worked at the sewage question as affecting Birmingham and Manchester, in which he resided from 1876 till 1879, to prosecute his work.

Mr. Cole was nominated a C.B. in 1852, and created a K.C.B. in 1875. In 1855 he was made Officer of the French Legion of Honour; in 1867 he received the Austrian Iron Crown.

Sir Henry Cole had recently been recommended caution on account of the condition of his heart, but no immediate danger was apprehended. On the day previous to his death he was engaged upon the public works that employed his time and thoughts. In the evening he became seriously ill, and died painlessly at 7.30 p.m. on Tuesday, April 18.

It is difficult to sum up the character of a man who has so recently passed away, but it may be said that his strong points were his retentive memory, his power of organisation, and his firmness of will. When all is said, he was a good and genial friend and a devoted servant of the public, and when the time comes for a history of English art education in the nineteenth century, it is not too much to say that one of the names which must stand to the fore will be that of Henry Cole.

NOTES

ON another page we make brief allusion to the irreparable loss which science has sustained in the death of Mr. Charles Darwin on the 19th instant, in his seventy-fourth year. We hope in an early number to refer in some detail to the vast and varied work which he has accomplished during the last half century. Yesterday, as was fitting, "he was laid among his peers in Westminster Abbey."

AT Monday's meeting of the Royal Geographical Society Lord Aberdare announced that the Founder's (gold) medal had been awarded to Dr. Gustav Nachtigal for his journey through Eastern Sahara in the years 1869 to 1875; and the Patron's (gold) medal to Sir John Kirk, K.C.M.G., M.D., her Majesty's Consul-General at Zanzibar, for his long-continued and unremitting services to geography in Dr. Livingstone's Zambesi expedition in 1858-63, and in the assistance he had rendered to successive expeditions in East Africa during his fifteen years' residence in Zanzibar.

ALTHOUGH he has bequeathed most of his large fortune to the French Government for scientific purposes, M. Henry Giffard has left legacies to several scientific institutions.

FROM a *Daily News* telegram we learn that on Monday night the Eclipse Expedition arrived at Gibraltar, all well. A stiff gale and heavy sea were encountered in the Bay of Biscay, but no damage was done to the instruments.

PROF. HAECKEL has reached Egypt on his way home from Ceylon; on returning to Germany after finishing his researches in Egypt, he will publish an account of his tour.

WE regret to state that M. Eugene Frederic Kæstner, the inventor of the Electrical Thermophone, which has produced such striking effects in Germany and and in Paris, died a few days ago at Strasburg after a long illness. He was only thirty years of age. This ingenious and laborious young man was the only son of M. Frederic Kæstner, who has written a number of most interesting works on the music of nature and musical philosophy. It was only owing to the illness of M. Kœstner and his inability to do any work at all for the last few months that his wonderful instrument had not been sent to in the Electrical Exhibitions of Paris and the Crystal Palace, but it is stated that steps will be taken to send it to the Munich Exhibition.

THE second edition of Vol. I. of Thomson and Tait's "Treatise on Natural Philosophy" is now nearly completed; Part ii. being in the press and to be published very soon by the Cambridge University Press. The work has been carefully revised, and amended in many parts. The parts "On the Attraction of

Ellipsoids," and "On the Equilibrium of Rotating Liquid Masses," have been re-written, with the addition of some results of fresh investigations in the last-mentioned parts.

THERE is also now in the press, very nearly ready for publication, a volume of Mathematical and Physical Papers, by Sir William Thomson. Generally the papers are arranged according to the date of first publication, but in some cases this rule is departed from and the articles on one particular line of research brought together. Amongst the more important papers included in this volume may be noticed the series of papers "On the Dynamical Theory of Heat," published from 1851 to 1878, with the addition of one on "Thermodynamic Motivity," published in 1879. Also the joint papers by Dr. Joule and Sir William Thomson on a long series of researches on "The Thermal Effects of Fluids in Motion," which they carried out together during the years 1853 to 1862. The volume includes also papers "On the Thermodynamics of Electrolysis" and "On the Theory of Electrodynamic Machines," which has acquired so much of general interest through the extensive practical applications which have been made of it for electric lighting and the electrical transmission of power within the last ten years. Additions and annotations have been made in many parts of the volume, but the original papers are given without even verbal change. Corrections, where errors have been found, have been distinctly marked in every case, and in most cases dated. This first volume includes all of Sir William Thomson's papers published between 1841 and 1853, except those which appeared ten years ago in his volume of collected papers on "Electrostatics and Magnetism." It will be followed as speedily as possible by other volumes completing the series to the present date.

THE second volume of the "Mathematical and Physical Papers" of Prof. G. G. Stokes, is now nearly complete, and will shortly be published. A third volume is in preparation, and it is intended to complete the series as soon as possible.

JUDGING from newspaper reports and private letters which we have received, much dissatisfaction has been created in Sydney by the recent appointment of two professors to fill the chairs of natural history and of anatomy and physiology in the University; and we think there can be no question that this dissatisfaction is of only too reasonable a kind. It seems, that instead of advertising the chairs as vacant, the Senate, at an unusually small meeting, hurried through the nomination and election of the two candidates who have been chosen, with the result of obtaining for the chairs of anatomy and physiology, a gentleman who, since he left college fifteen years ago, has had no connection with anatomical or physiological work; and for the chair of natural history, an elderly gentleman who has been all his life a master of a grammar school. As the emoluments attaching to these chairs are sufficient to attract men of the highest standing from any part of the world, it is difficult to speak in strong enough terms of the conduct of the meeting of Senate at which the appointments were made; and we sincerely hope, for the sake of science as well as for that of the University, that public opinion in Sydney may prove strong enough to prevent the recurrence of any such—to use the mildest term—mis-guided policy.

THE South-Eastern Railway Company have withdrawn their opposition to the underground electric railway, which it is proposed to construct from Charing Cross, at a point near the north-west end of Northumberland Avenue, passing under the River Thames, and terminating at Vine Street, under the loop-line station of the Waterloo terminus of the London and South-Western Railway. The Parliamentary Committee have passed the bill.

THE French Government is making preparations to send out an Antarctic expedition to Cape Horn. M. Mascart, the head of the Bureau Central, has been communicated with, for the appointment of meteorological and magnetical observers. The expedition will be fitted out for a period of eighteen months, and 2½ million francs have been voted for it.

BY authorisation of the Russian Minister of Public Instruction, the Imperial University of St. Petersburg is about to found an astronomical observatory, which will be of small size conformably to its principal object, which is to facilitate the studies of those who are engaged in the University curriculum. The principal pieces forming the *matériel* will be two refractors, with Merz object-glasses, one 6 inches aperture, the other 4 inches, parallactic mounting and clockwork motion, several transportable astronomical instruments, and an astronomical clock with some other secondary instruments.

WE take the following from the *Photographic News*:—"They are going to try a strange experiment in Paris. The idea is to combine amusement with scientific instruction, by producing at one of the theatres a series of scientific dramas. The Folies Dramatiques is the theatre chosen for the purpose, and the experiment is to commence during the summer months. Already three plays have been provided for this bold scheme, and their titles indicate plainly in what direction the audience is to be instructed. The first drama is called 'Denis Pepin, or the Invention of Steam'; the second is entitled 'Kepler, or Astronomy and the Astrologer'; and the third is 'Gütenberg, or the Invention of Printing.' We would suggest yet another title: 'The Triumvirate—Niepce, Daguere, Talbot—or the Invention of Photography.'"

AT a recent meeting of the Seismological Society of Japan, Prof. Milne read a paper on the "Distribution of Seismic Activity in Japan." This paper was to a great extent founded on communications received from almost all parts of Japan in answer to inquiries respecting the occurrence of earthquakes in various districts. As the result of these inquiries during the past two years, Mr. Milne had received, in addition to general opinions respecting the seismic activity of various districts, a very large number of actual records. Commencing in the north and proceeding to the south, notes and catalogues of earthquake intensity for the whole country were given. Thus for Hakodate, in Yezo, from 1876 to 1880 a catalogue of forty-two earthquakes was given. By comparing this catalogue with that of Sapporo, in the same island, it was seen that ten at least of the Hakodate shocks had been felt at Sapporo, eighty miles to the north-east; and similarly it was shown that seven of the shocks were felt at Tokio, five hundred miles to the south. From the times at which a shock was felt in different localities, its intensity and the like, origins for certain shocks were roughly computed. The district around Tokio is of course that which is being most thoroughly investigated; and as it was only possible to obtain *accurate* observations as to the time at which shocks were felt at one or two localities, and farther, as it was shown that the direction in which the earth moved at any given point as indicated by a seismometer did not necessarily indicate the direction from which the earth waves were advancing, Mr. Milne has adopted the following simple method as an assistance in tracing earthquakes to their origins. All important towns within a radius of one hundred miles from Tokio have been furnished with bundles of post-cards, one of which is posted every week stating whether earthquakes have or have not been felt. In this way, at the end of last year, Mr. Milne found that the greater number of the earthquakes which were felt in Tokio had only been felt in the towns to the north of that city, and a short distance to the south. This fact being established the barrier of post-cards was continued about two hundred miles still farther north, with the result of inclosing, so to speak, the origin of several shocks, and tracing others to the sea-shore. The latter could no longer be pursued by means of post-cards, and instru-

mental observations alone had to be relied on for the determination of their origin. These observations, so far as they have at present gone, show in a remarkable manner how a large mountain range absorbs earthquake energy. Thus, it is very seldom that an earthquake travelling from the north passes beyond the Hakone range of mountains to the south of Tokio. Earthquakes having their origin on either side of such a range rarely travel to the other side, however large their area of activity on their own side may be. The whole of Japan has in this way been divided into districts of varying seismic activities. By two separate systems of investigation Mr. Milne showed that, if instruments of ordinary sensitiveness were distributed throughout Japan there would on the average be recorded, at the lowest estimate, over 1200 shocks per year, or about three shocks per day, which is a number greater than that obtained by Prof. Hein for the whole world.

THE last number of the *Journal* of the North China branch of the Royal Asiatic Society contains a long and learned paper by Dr. Bretschneider, of the Russian Legation at Pekin, on Chinese Botany. The plan of the work, of which the present is only an instalment, is explained as follows. It is divided into a general and a particular part. The first, which forms the substance of the present paper, begins with a review of the history of botany, agriculture, and Materia Medica of the Chinese and other Eastern Asiatic nations, and enters into some details concerning the most prominent treatises and authors in these departments. In the same chapter he shows the method employed by the Chinese in describing plants and in investigating botany and materia medica. Another chapter is devoted to the important question of identifying Chinese names of plants with the scientific botanical names, and to recording the attempts made by European scholars to ascertain the botanical names of the plants described in Chinese books. The first part will conclude with an alphabetical list of Chinese works, and another of Chinese authors quoted in native botanical treatises. In the second part, the author will give a history of Chinese domestic, ornamental, medicinal, and other plants used for economic purposes, as far as these have come to the knowledge of botanists. The work, it will thus be seen, involves a vast amount of laborious research in European as well as Chinese literature. The present number contains chapters on the history of the development of botanical knowledge among the various peoples of Eastern Asia, and on the scientific determination of the plants mentioned in Chinese works, together with an index of Chinese writers on botany, and an appendix on celebrated mountains in China, which are frequently mentioned in Chinese botanical works. Dr. Guppy, R.N., gives some notes on the hydrology of the Yangtze, Yellow River, and Peiho, and also on the geology of Takow in Formosa. The other paper is by Father Dechevrens, S.J., on the climate of Shanghai. The number closes with a list of the ferns found in the valley of the Foochow River.

THE fourth number of the *Memoirs* of the Science Department of the University of Tokio is a monograph on the geology of the environs of Tokio, by Prof. Brauns; while the fifth contains a paper by Prof. Mendenhall on the force of gravity at Tokio and on the summit of Fujiyama. Dr. Naumann, the head of the Japanese Geological Survey, has recently published a monograph on Japanese elephants. The writer has found remains of these mammals in various widely separated districts. This paper will be found in vol. xxviii. of the "Palæontographica," published by Fischer of Cassel, and is entitled "Ueber Japanische Elephanten der Vorzeit."

IN the Belgian Academy, M. Plateau has lately called attention to a small illusion. He describes an arrangement which, at first sight, he says, might be thought capable of realising perpetual motion. A capillary tube is inserted obliquely in distilled water, so that the latter nearly fills it. Into this liquid column, at the top, dips the small orifice of another tube, which reaches a little way in the same oblique direction, then turns downwards, the vertical portion being wider, and not reaching the water. Suppose this bent tube filled with water. It then forms a siphon, the shorter branch of which is immersed in a liquid in equilibrium, while the longer descends several centimetres below the surface of that liquid. Does it not appear as though the water should flow incessantly through the siphon, and, regaining the vessel, be engaged in perpetual circulation? As a matter of fact, the water is drawn upwards in the vertical portion of tube till its free surface reaches a part of the oblique part of the same tube, when it stops. M. Plateau accounts for the effects by suction exerted by the small concave liquid surface between the two tubes

A NEW dynamo-electric machine, recently brought before the Belgian Academy by M. Plücker, has the peculiarity that a solenoid is substituted for the electromagnet as an organ for excitation of the induction currents. The horizontal coils of the solenoid, which is of special form, are traversed by the currents produced by the machine itself. The apparatus rotated within the solenoid is a wheel with coils arranged nearly like those of the Gramme ring. The whole system is inclosed in an iron armature meant to increase the inductive action. M. Plücker states that he replaced the solenoid with electromagnets, and the apparatus produced the same effect. He seems merely to claim the advantage of less weight and volume.

A SERIOUS difficulty recently occurred at Berlin, in connection with a system of supply of "ground water" by "natural filtration" (a part of the Berlin water supply having been taken since 1877 from near the Tegeler Lake, by means of a series of twenty-three wells running parallel with the shore; the water was pumped into a small covered reservoir, then to another at Charlottenburg, 6 or 7 kilom. distant, whence pumps supply the city). Complaints arose on account of the water, though clear at first, getting turbid ere long, and depositing an ochreous sediment found to consist of amorphous hydrated oxide of iron, but also very largely of algæ, dead and alive; *Crenothrix kühniana* (a plant of thready form), being most noticeable. The source of the plants could neither be located in surface-water, nor in the neighbouring lake; and there is reason to believe the plant lives and grows in the ground itself. After sundry attempted remedies it seemed that artificial filtration would be necessary. It was found that water brought directly from the wells to the filter, gave, after filtration and rest, the usual deposit. But by exposing this well-water to the air, so that all the iron was oxidised and deposited before filtration, it was possible to get a filtered water which remained clear; though it is not known whether this filtered water was really free of spores, and would continue clear after being in contact with the iron of the service. Iron seems essential to the existence of *Crenothrix*, and is proved to be present in its threads. The filter-sand was very much fouled, and, because of the difficulty of keeping out spores, it was thought best to abandon the wells altogether, and to use water taken directly from the lakes and filtered in the usual way. Prof. Nichols (who reports these facts in the Franklin Institute *Journal*) refers to somewhat similar troubles having been experienced at Halle, and at a town in the east of Massachusetts.

THE following subjects are announced by the Belgian Academy for prize competition:—In mathematical and physical sciences: Establish, by new experiments, the theory of reactions of bodies in the so-called nascent state. Prove the accuracy or falsity of the following proposition by Fermat: To decompose a cube into two other cubes, a fourth power, and generally any power into two powers of the same name, above the second power, is im-

possible. New spectroscopic researches required as to whether, especially, the sun does or does not contain the essential constituent principles of organic compounds. Extend, as much as possible, the the theories of points and straight lines of Steiner, Kirkman, Cayley, Salmon, Hesse, and Bauer, to the properties which are, for superior plane curves, for surfaces, and for skew curves, the analogues of theorems of Pascal and Brianchon. In natural sciences: New researches required on germination of seeds, especially on assimilation of nutritive stores by the embryos New researches required on development of Trematodes, from the histogenic and organogenic points of view. New stratigraphical, lithological, and palæontological researches required, to fix the arrangement or the order of succession of layers of the formation called Ardennais by Dumont, and at present considered a Cambrian. Medals valued at 800 francs will be given as prizes in the first division; medals of 600 francs in the second. Memoirs may be written in French, Dutch, or Latin, and should be sent (in the usual form) to the Secretary, before August 1, 1883.

THE number of large carnivorous animals killed in Algeria is diminishing yearly with great rapidity. In 1879 the Government paid for 166 heads of lions and panthers; and in 1880 only for 128, viz. 16 lions, 100 adult panthers, and 16 young. It is certain that in a very few years they will be entirely extirpated. They are now very seldom met with, except in some mountainous parts, and almost wholly deserted districts of Constantine province. When the conquest was made, they were occasionally seen at the gates of Algiers, and so frequently on the sea-coast, that a cape near Arzav received the name of "La Montagne des Lions," which it has retained.

THE electrical perturbations were so frequent on the French lines from April 16 to 20, that measures had to be taken by the Minister of Postal Telegraphy to meet this contingency. The electrical equilibrium was restored on the 21st. These electrical perturbations were noticed on the telegraphic lines of Germany, Belgium, and Italy, and of England, according to the notice which was published by the French Administration in the official paper of the Government.

A SLIGHT earthquake shock was felt at Geneva on Thursday, and a smart one on the previous Monday in the Vaudois and Jura. On both these days the telegraphic wires here were affected, which produced a violent oscillation of the needles. Similar perturbations were observed at other stations. A violent earthquake is reported from Syra (Greece). The shocks lasted nearly a minute, yet but little damage was done. On the Ætolian coast the sea has still its blood-red colour, and the smell of sulphuretted hydrogen becomes more and more intense.

THE *Daily News* Naples Correspondent writes on the 21st:—"The central crater of Mount Etna has been throwing up ashes for the last two or three days, covering the pure new snow lately fallen with a stratum of black ashes on the south-east side. The mud eruption at Paterna continues, but is limited to one crater, from which flows hot and liquid mud."

THOSE interested in the very wide region included in "the East," will find the "Bibliotheca Orientalis," published by Trübner and Co., very useful. It is stated to be a complete list of books, papers, serial, and essays published in 1881 in England and the Colonies, Germany, and France, on the History, Languages, Religions, Antiquities, and Literature of the East, compiled by Charles Friederici. This is the sixth year of publication.

A SIMPLE new thermometer, said to be very sensitive, has been described (*Jour. de Phys.*, April) by Mr. Michelson. It depends on the expansion of hardened caoutchouc by heat. A very thin strip of the substance is attached to a similar strip of copper. The lower end of the double strip is fixed, and the other has attached to it a fine glass fibre bent at a right angle, through which, as the strip bends under heat, motion is imparted to a very light silvered-glass mirror, hung by a cocoon fibre. The displacement of the mirror is observed with a telescope and reflected scale, or by the movement of a spot of light. To avoid sudden changes of temperature, the double strip is inclosed in a metallic case having a slit opposite the strip. In a modification, which the author has not yet tried, the strip is reversed, and the lower end enters a highly resistant liquid, in which it faces a metallic point; the two serve as electrodes, connected with a galvanometer and a Wheatstone bridge.

AT the thirteenth annual meeting of the Norfolk and Norwich Naturalists' Society, the president stated that during the session which was past, a considerable number of papers had been read and specimens exhibited, which were not of interest to scientific people only. The popular taste demanded something beyond that. The society had endeavoured to meet this requirement. The number and strength of the Naturalists' Society grows with its years. At the last annual meeting the society numbered 202 members; the number now reached is 234. A very good feature has been the formation of a naturalists' library. The concluding portion of the address was occupied with a survey of certain features in the Ornithology of Norfolk at the present day, some of which were a cause of congratulation and others of regret. As, for instance, the short-eared owl, which had for some years ceased to be a resident species in Norfolk, had again been known to nest and rear its young in both divisions of the county; and the hawfinch seemed yearly to increase in favourable localities.

ONE more American serial comes to us in the shape of the Scientific *Proceedings* of the Ohio Mechanics' Institute, containing a number of papers of practical importance, including a long one on Economy of Fuel, by Mr. N. W. Perry.

WE have on our Table the following books:—Volumetric Analysis, 4th edition, by F. Sutton (Churchill and Co.); A Manual of Botany, 4th edition, by R. Bentley (Churchill); Permanence and Evolution, by S. E. B. Bouverie-Pusey (Kegan Paul); Annuaire de l'Academie Royale de Belgique (1882, Brussels); Observations on Cup-shaped and other Lapidarian Sculptures in the Old World and in America, by Charles Rau (Washington); Vibratory Motion and Sound, by Prof. J. D. Everett (Longman); Microscopical Section Cutting, by Sylvester Marsh (Churchill); The Fishes of Great Britain and Ireland, by Francis Day (Williams and Norgate); The Scientific Bases of National Progress, by J. Gore, F.R.S. (Williams and Norgate); Jamaica Institute Lectures, 1881 (Kingston, Jamaica); The Butterflies of Europe, Part vii., by H. C. Lang (Reeve and Co.); A Visit to Madeira, by Dennis Embleton, M.D. (Churchill); Religion and Philosophy in Germany, by Heinrich Heine, translated by John Snodgrass (Trübner); A Monograph of the British Fossil Cephalopoda, Part i. by J. F. Blake (Van Voorst); Elementary Physiology, by A. Findlater (Chambers); Vital Statistics: Small Pox and Vaccination, by Dr. C. T. Pearce; (E. W. Allen); A Manual of the Geology of India, by V. Ball (Calcutta); Rivers and Canals, 2 vols., by L. F. V. Harcourt (Clarendon Press); The Sphygmograph, by Dr. Dudgeon (Baillière, Tindall, and Co.; On Failure of Brain Power, by Dr. Julius Althaus (Longmans); Plane Geometrical Drawing, by F. E. Hulme F.S.A. (Longmans); The Action of Lightning, by Major Parnell, R.E. (Lockwood); Beauty, and the Laws Governing its Development, by Joseph Hands (E. W. Allen); New Views of Matter, Life, Motion, and Resistance, by Joseph Hands (E. W. Allen); Astronomical Observations made at Dunsink, Part 4 (Hodges, Foster, and Co.); Houses and Farms in America, by Dr. G. H. Everett (C. Dickie); Modern Metrology, by L. D'A. Jackson

(Lockwood); The Coming Transit of Venus, by William Peck (R. Symon); The Horse in Motion, by J. B. D. Stillman (Trübner); Bibliotheca Orientalis, by C. Friederici (Trübner); Contributions to the History of the Development of the Human Race, by Geiger (Trübner).

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus radiatus* ♀) from India, presented by Mr. W. T. Fremlin; a Two-spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Mr. A. N. Blyth; a Rufous Rat Kangaroo (*Hypsiprymnus rufescens* ♀) from Australia, presented by Mr. C. Caravossi; two Cockateels (*Calopsitta novæ-hollandiæ* ♂ ♀) from Australia, presented by Mr. W. C. Atkinson; a Common Raven (*Corvus corax*), British, presented by Mr. H. E. Langton; a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, presented by Mrs. Ramsay; a Lanner Falcon (*Falco lanarius*), from East Europe, presented by Mr. J. E. Harting, F.Z.S.; a Common Night Heron (*Nycticorax griseus*), European, presented by Mr. H. D. Compton; a Lesser White-nosed Monkey (*Cercopithecus petaurista* ♂) from West Africa, a Cabot's Horned Tragopan (*Ceriornis caboti* ♂), from South-West China, deposited; a Silvery Gibbon (*Hylobates leuciscus*) from Java, a Mongoose Lemur (*Lemur mongoz* ♂), a Red-fronted Lemur (*Lemur rufifrons* ♂), two Grey-headed Love Birds (*Agapornis cana* ♀ ♀) from Madagascar, a Squirrel Monkey (*Chrysothrix sciurea*), a —— Squirrel Monkey (*Chrysothrix*, sp. inc.) from Guiana, two Rufous-tailed Pheasants (*Euplocamus erythropthalmus* ♂ ♀) from Malacca, a Wheatear (*Saxicola œnanthe*), a Meadow Pipit (*Anthus pratensis*), a Redstart (*Phœnicura ruticilla*), British, a Burchell's Zebra (*Equus burchelli* ♂) from South Africa, purchased; an Eland (*Oreas canna* ♂), two Short-headed Phalangers (*Belideus breviceps*), a Squirrel-like Phalanger (*Belideus sciureus*), four Slender Ducks (*Anas gibberifrons*), two Common Cormorants (*Phalacrocorax carbo*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

THE OBSERVATORY OF TRINITY COLLEGE, DUBLIN.—The fourth part of "Astronomical Observations and Researches made at Dunsink" has just appeared under the editorship of Mr. J. L. E. Dreyer. It contains the results of about 1140 observations of 321 red stars, chiefly taken from Schjellerup's Catalogue, made with the meridian-circle of the Dunsink Observatory, the object-glass of which has an aperture of 6·38 inches, the instrument being the work of Piston and Martins of Berlin. The observations were commenced by Dr. Copeland in July, 1875, and continued by him up to the end of March, 1876. Mr. Dreyer commenced observations in September, 1878, and the series was finished in November, 1880. As far as possible, it has been the object to secure four complete observations of each star. The separate results are printed, with the corresponding dates and estimates of the magnitudes of the stars which have a particular interest from the fact of so many of the red stars being variable. The Dublin observations show this to be the case in a striking degree, and not only is there variation in the brightness of many of the objects, but it is hardly possible to doubt that they establish changes of colour from time to time in some of the stars. Thus we find No. 5 (Schjellerup) was *white* on November 14, 1875, and *deep orange* three months later. No. 143 was considered *orange* on February 28, 1876, but showed *no colour* on March 19; in March, 1880, it was again orange. No. 186 had no colour on April 30, 1880, but was deep orange on June 10 following; and there are a number of similar cases, too many, it would appear, to allow of their being attributable to varying conditions of atmosphere.

The observed positions of the 321 stars are formed into a general Catalogue for 1875·0, with the corresponding precessions, which will have much value in the study of the proper motions of the red stars.

THE OBSERVATORY OF MOSCOW.—Prof. Bredichin has issued the first part of vol. viii. of *Annales de l'Observatoire de Moscou*, which in addition to meridian observations, contains a continuation of his researches upon the tails of comets, the present publication including the comets 1881 *b* and *c*, and the fourth or great comet of 1825. Prof. Bredichin has reprinted the long series of physical observations on the latter body made by Dunlop at Paramatta N.S.W., which originally appeared in Brewster's *Edinburgh Journal of Science*, 1827, and which have been a good deal overlooked, that periodical, on the continent at least, not being easy of access. Dunlop's drawings are reproduced, and there are several figures of the two bright comets of 1881. With regard to his investigations generally, Prof. Bredichin concludes: "Mes recherches sur toutes les Comètes, dont les observations j'ai pu trouver dans la littérature astronomique (36 comètes) me mettent maintenant en état de calculer d'avance pour chaque grande Comète qui paraîtrait les positions et la figure de ses queues de tous les trois types. Il est evident que la quantité rélative des substances caudales de différents types ne peut pas être determinée d'avance, et par conséquent c'est seulement l'observation qui pourra nous montrer et la clarté rélative des types et l'absence possible de tel ou tel d'entre eux. Mais en tout cas, les positions et la forme générale de celle des queues, qui deviandra, accessible à la vision, seront en accord avec ses positions et sa figure calculées d'avance."

THE PRESENT COMET.—The following positions for Greenwich midnight are from the elements published last week. On April 16 the calculated place was in error −7s. in R.A. and −2′ in declination, but the errors will be increasing.

	R.A. h. m.	Decl. ° ′	Log. distance from Earth.	Sun.
May 2	20 52·4	+69 53	9·9904	0·0793
4	21 22·6	71 40	9·9818	0·0632
6	21 59·5	73 9	9·9740	0·0461
8	22 43·4	74 10	9·9671	0·0280
10	23 32·8	+74 35	9·9610	0·0087

The perihelion distance in the orbit referred to which depends on observations to April 6 is 0·0560; M. Bigourdan, from observations at Paris to April 11, finds it 0·0602.

GEOTROPISM AND GROWTH[1]

IF the *punctum vegetationis* of a root is removed by a transverse section, the root loses more or less completely the power of curving geotropically downwards when placed in a horizontal position. This curious experiment was originally made by Ciesielski, and has been confirmed by the observations described in "The Power of Movement in Plants" (chap. xi.). The theory founded by Mr. Darwin in these observations is that the *punctum veg.* is the part of the root which is sensitive to gravitation, and that a stimulus is thence transmitted to the region of growth where the geotropic curvature takes place. But it is evident that the facts are capable of a different interpretation, it might be supposed that cutting off the tip of the root acts merely as a shock, and prevents the occurrence of geotropism, just as any other severe injury might do so. This view has recently been brought forward by Wiesner ("Das Bewegungsvermögen der Pflanzen," 1881, p. 97), and is supported by him with a number of experiments on the growth of decapitated roots. The results of some of Wiesner's experiments are given below, the figures representing the amount of growth per cent. in twenty-four hours:—

	Normal Roots.		Decapitated. Roots	
Maize.	77·5	...	41	or as 100 : 52·9
Peas.	42·7	...	9·7	,, 100 : 22·7
Vicia Faba.	90	...	60	,, 100 : 66·6

Wiesner believes that this difference in growth between the normal roots and those of which tips had been cut off is sufficient to account for the disturbance in geotropism. It should be added that in Wiesner's experiments geotropism was not so completely checked by cutting off the tips of the roots as in those given in the "Movements of Plants."

In the present paper the intervals of time between the observations on the rate of growth were shorter than in Wiesner's experiments—namely, about three hours instead of twenty-four hours; the reason for this difference being that geotropic curva-

[1] A paper read before the Linnean Society, April 6, by Mr. Francis Darwin.

tures generally take place long before twenty-four hours have elapsed.

Dots were made on the roots (*Vicia Faba*) at different distances from their tips, so that the spaces thus marked out could be measured by means of a microscope. The beans were placed during the experiment in closely-shutting tin boxes, nearly filled with damp peat.

A considerable number of experiments were thus made, and the results obtained do not confirm those of Wiesner, but agree rather with Sachs' statement, that cutting off the tip of a bean root does not seriously hinder its growth. They show, moreover, that the effect of the operation is transitory, and that as the roots recover from the shock, they may actually grow more quickly than the uninjured specimens. Thus in one of the experiments the roots were marked at 2 mm. and 5 mm. from the apex, and the intervening space was measured after 3h. 10m., and again an additional interval of 3h. 5m. During the first 3h. 10m., if the growth of the normal roots be taken as equal to 100, that of the "cut" ones was 78; during the second period the proportion was:—normal to "cut" as 100 to 102; that is to say, the "cut" roots grew more quickly than the uninjured ones.

Other experiments gave the same result; on the other hand some cases occurred in which the power of recovery was not so rapid or well marked. Thus in one experiment the growths (per cent.) after twelve hours were in the proportion:—Normal : Cut : : 100 : 83, so that the growth of the "cut" roots was less by 17 per cent. than that of the uninjured ones.

On the whole the experiments show distinctly that a loss of geotropism may occur without serious interference with growth. The author then goes on to show that even if this were not so, it could still be shown that Wiesner's conclusion is incorrect.

If a root is split by two longitudinal incisions into three lamellæ, and if it be placed horizontally, so that the cut-surfaces are in a vertical plane, Sachs has shown that the central portion of the root containing the chief part of the vascular tissue, is capable of bending geotropically downwards. It was therefore thought desirable to compare the rates of growth of such split roots with others whose tips had been cut off. The result showed that the "cut" roots grow much more vigorously than the split ones. Thus we have in one experiment—

Cut : split : : 100 : 68·7.
In another—Cut : split : : 100 : 67·4.

Yet here the only clear geotropism that took place was among the split roots.

Thus Wiesner's argument falls to the ground, for, if retarded growth were the cause of "cut" roots being less geotropic than uninjured ones, it is clear that "split" ought to be even less geotropic than the "cut" roots, instead of exactly the reverse of this being the case.

The results here given are of some general interest, as showing, that although geotropism is a phenomenon of growth, it need not necessarily be subject to strictly the same conditions as undisturbed growth.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following lectures on natural science are being given this term ;—

Chemistry and Physics : Prof. Liveing on General Principles of Chemistry ; Mr. Sell (Demonstrator), Elementary Chemistry ; General Course, Mr. Main, St. John's College ; Organic Chemistry, Mr. P. Muir, Caius College ; Sound, Mr. Trotter, Trinity College ; Electricity and Magnetism, Mr. Garnett, St. John's College ; Papers on Elementary Physics, Mr. Shaw, Emmanuel College ; Elementary Optics and Electricity, Mr. Glazebrook, Trinity College ; Crystallography, Prof. Lewis ; Physics (advanced), Mr. Garnett, St. John's College ; Advanced Demonstrations on Light, Elasticity, and Sound, will be given by Mr. Glazebrook, and Mr. Shaw will give elementary demonstrations on Optics and Electricity, both in the Cavendish Laboratory. Practical Chemistry, in the University, St. John's, and Caius College Laboratories.

Biology :—Elementary, Dr. Michael Foster ; Advanced Physiology, Mr. Langley ; Physiology of Respiration and Animal Heat, Dr. Gaskell ; the Eye and Vision, Mr. Lea ; Physiology, for Tripos and 2nd M.B., Mr. Hill, Downing College ; Human Anatomy, Demonstrations for Tripos students, Dr. Creighton ; Mechanics of Human Skeleton, Mr. McAlister, at old Anatomical School ; Mr. Sedgwick, Embryology of Mammals and Birds, in Mr. Balfour's Laboratory, followed by practical work ; Advanced Course on Mammalia, by the Demonstrator of Comparative Anatomy at New Museums. In Botany, Prof. Babington will lecture on Morphology and Classification ; Dr. Vines, on Morphology, chiefly Cryptogamic, with practical work, at Christ's College ; Mr. Saunders, on Histology, at Downing College, Mr. Hicks, Sidney College, papers in Elementary Botany. Mr. Vines is also giving an elementary course of lectures on General Physiology and Life History of Typical Plants, in the Botanical Lecture Room, New Museum.

Geology :—Prof. Hughes, Stratigraphical Geology, the district around Cambridge ; Fossil Echinids and Corals, and also Petrology, Mr. Tawney ; Elementary Geology, Dr. Roberts ; Class Work, Mr. Marr ; Field Lectures, Prof. Hughes.

The Demonstrator of Mechanism is lecturing on Applied Mechanics at the Museum of Mechanism ; and the workshops and drawing office are open for practical work.

Prof. Stokes is lecturing on Optics.

C. N. Adams (Exeter School) and S. Skinner (Dulwich College) have been recommended for Natural Science Open Scholarships at Christ's College.

At Newnham College Mr. Garnett is lecturing on Dynamics, Miss Scott on Integral Calculus, and Miss Harland on Euclid and Algebra.

THE Spring Session of the Royal Agricultural College, Cirencester, ended on Wednesday, 19th inst., when the diploma, certificates, and prizes were distributed to the successful candidates by Prof. Nevil Story-Maskelyne, M.P., who has been recently elected to the Council of the College. Mr. Maskelyne, in his address to the students, pointed out the great value of a study of the lower organisms, and the immense influence which these have on the pursuit of agriculture, as is seen in the process of nitrification, the changes taking place in milk, in cheese, and the like.

At St. John's College, L. J. Fuller has been elected to a Natural Science Exhibition.

At Trinity College W. B. Ransom (2nd year) has been elected to a Foundation Scholarship ; H. Wilson Fox, H. Head, M. Miley, G. P. Bidder, and W. Gordon, to Exhibitions ; and J. R. Green to a Foundation Sizorship ; all for Natural Science.

EDINBURGH.—Prof. James Cossar Ewart, M.D., has been appointed to the Chair of Natural History in Edinburgh University, vacant by the resignation of Prof. Ray Lankester. Prof. Ewart at present holds the corresponding chair in the University of Aberdeen.

SCIENTIFIC SERIALS

WE have received Nos. 44, 45, and 46 of the *Scottish Naturalist*. The papers on Scotch botany and zoology continue to be of great interest ; and to these are added an occasional one on Scotch geology. No. 46 (April) contains a report of an interesting lecture, by Prof. Traill, on "The Modes of Dispersion of the Seeds of Scottish Wild Plants."

Journal of the Franklin Institute, March.—A new theory of the suspension system with stiffening truss (continued), by A. J. Du Bois. The adhesion of flat driving belts, by R. Grimshaw. —Car-journal boxes, with Wendell's latest improvement, by C. H. Roney.—Thompson's patent wet pulveriser, by the same.—A new method of determining phosphoric acid, by H. Pemberton, jun.—The analysis of iron ores containing both phosphoric and titanic acids, by T. M. Drown and P. W. Shimer. The condition of sulphur in coal and its relations to coking, by T. M. Drown.—Natural filtration at Berlin, by W. R. Nichols.—Silk culture in the United States, by L. Blodget.

Bulletin de l'Academie Royale des Sciences de Belgique, No. 1, 1882.—On a sure astronomical criterion of the existence of a fluid layer within the terrestrial crust, by M. Folie.—A small illusion, by M. Plateau.—New observations of the effects of lightning on trees placed near a telegraph wire, by M. Montigny. —Influence of respiration on the circulation (third paper), by M. Fredericq.—On a method of determination of latitude, by M. Adam.—Researches on the dialysis of arable soils, by M. Petermann.—On the excretory apparatus of rhabdocœl and dendrocœl Turbellarians, by M. Francotta.—New parasitic worms of *Uromastix acanthinurus*, by M. Fraipont.—Dynamo-electric

machine with inductor-solenoid and continuous current, by M. Plücker.—Reports, &c.

No. 2.—Determinism and liberty; liberty demonstrated by mechanics, by M. Delbœuf.—On the origin of the Devonian limestones of Belgium, by M. Dewalque.—On the zircon of the quarries of Nil St. Vincent, by M. Renard.—On monochlorised chloride of acetyl, by M. Krutwig.—Influence of respiration on the circulation (fourth paper), by M. Fredericq.—Funeral discourses on M. Schwann and Col. Aden.—Reports, &c.

Archives des Sciences Physiques et Naturelles, March.—Influence of physico-chemical media on living beings; influence of different kinds of food on the development of the frog, by I. Yung.—Disinfections with sulphurous anhydride; siphonoid apparatus with special *transvaseur*; description of apparatus and management, by V. Fatio.—Swiss geological review for 1881 (continued), by E. Favre.

Révue d'Anthropologie, tome v., fasc. 1, 1882.—M. Paul Topinard's paper, on the weight of the brain, gives a comprehensive summary of all that had been done by Broca in this branch of craniology since the foundation of the mother-society at Paris, in 1861. Broca's tables, including upwards of 1000 of his own observations, were being revised by himself at the time of his death, and these, the further revision of which has been intrusted to M. Topinard, are given at length, together with his own emendations, from which he has been led to conclude that excessive weight of the brain cannot, *primâ facie*, be accepted as an evidence of great intellectuality, but may fairly be assumed to depend upon some cerebral abnormality. Thus he is of opinion, that even in the case of Cuvier's brain, whose exceptionally large weight (1829 grammes) has long made it rank among cerebral marvels, the well-attested presence of hydrocephalus during the infancy of the great naturalist was not without influence on the subsequent cranial enlargement. Finally, he believes that we are justified in assuming that a well organised brain will not *very largely* exceed the mean, having due reference to age, sex, and stature. From Broca's tables we obtain a cerebral mean of 1325 for men generally, and of 1142 for women generally; the greatest weight among the former being attained between the ages of thirty and thirty-five, and among the latter, somewhat earlier. After the age of fifty-five, the diminution is rapid, and at the age of eighty it has reached the mean of 100 grammes, although the loss sometimes amounts to 250 grammes. The means for the prime of life are 1421 for men, and 1269 for women. In considering the data generally, it is essential to bear in mind that the individuals under observation were of necessity derived from the less favourable class supplied by asylums and hospital, and, therefore, presenting generally traces of disease, more especially of the brain, La Salpetrière and Bicêtre having yielded the greater number of the brains, commented on by Broca. The great desideratum of modern cerebral inquiry is the careful determination of the difference of the weight of the brain among mentally sound individuals belonging to the two distinct classes of those who are engaged in intellectual pursuits, and those whose vocations demand great muscular activity. Broca considered that form was more important than weight in estimating intellectual capacity, which possibly depends upon qualitative, and perhaps chemically inappreciable, rather than mere quantitative, relations. —M. Topinard, in a paper on the cephalic index, as determined according to Broca's method on the living subject, and after death explains the grounds on which he, in harmony with Prof. Vogt, has been led to consider as unnecessary and even erroneous, the reduction which it has hitherto been thought imperative to make, in order to bring the cephalometric estimate into complete accord with the craniometric determinations. He believes we ought to compare the two without making any reduction.—The capacity of the Black African races for becoming acclimatised, which is treated at great length by Dr. A. Corre, forms the subject of the only other original article in the *Révue*. The author, whose views are based upon observations made during many years residence in Senegal and other African inter-tropical regions, regards the African blacks as destined from the inherent inferiority of the race to give place in course of time to European immigrants. Beyond the possession of immunity against yellow fever and certain forms of marsh fever, he considers them to be inferior to whites in their powers of resistance against disease and general climatic conditions, and consequently inapt for military service, or for the purposes of colonisation, while finally he believes that the inaptitude of the negro for every high form of sociological development is such that there is only one of two things to be anticipated in regard to the lands occupied by the black races, viz. that where the latter are the masters, barbarism will prevail, and that where they fall into subjection to civilised peoples, their numbers will gradually, but surely diminish, in spite of the more favourable conditions in which they will be placed.

SOCIETIES AND ACADEMIES

London

Geological Society, April 5.—J. W. Hulke, F.R.S., president, in the chair.—W. J. H. Mylne was elected a Fellow, and M. Alphonse Milne-Edwards, of Paris, a Foreign Correspondent of the Society.—Geological age of the Taconic system, by Prof. J. D. Dana, F.M.G.S. The author takes exception to some remarks made before the Geological Society by Dr. T. Sterry Hunt on November 16 last. Dr. Sterry Hunt has thrown doubt on the results arrived at by the geologists who have studied the relations of the so-called Taconic strata, not in consequence of any observations of his own, but on the general ground that "where newer strata are in unconformable contact with older ones, the effect of lateral movements of compression, involving the two series, is generally to cause the newer and more yielding strata to dip towards, and even beneath the edge of the older rock—a result due to folds, often with inversion, sometimes passing into faults." It was pointed out in opposition to these views, that the observations of Emmons, H. D. and W. B. Rogers, Mather, Sir W. Logan, James Hall, E. Hitchcock, C. H. Hitchcock, Hager, and Wing, prove that the Taconic schists and limestones are in conformable succession and of Silurian age. The stratigraphical structure of the Taconic range is, indeed, so simple that all observers who have studied it have described the schists and limestones as conformable; and numerous characteristic Silurian fossils have been found in both. This view had been maintained by Dr. Sterry Hunt himself till 1878, when he first propounded his new interpretation of the strata in question; but the latter was not based on any fresh facts or observations. The author's own observations on the subject, carried on during many years, were detailed and illustrated by a map of the whole of the Taconic range. In conclusion, he pointed out that, even if Dr. Sterry Hunt's general principle were conceded, and he was not by any means himself prepared to make such a concession, it would have no bearing on the point at issue; for the supposed younger strata do not dip against the Taconic schists. In opposition to the view that the geological age of strata can be inferred from their mineral characters, he pointed out what remarkably different rocks have been produced by the metamorphism, in different degrees, of the strata of the Taconic range.—On some Nodular Felsites in the Bala Group of North Wales, by Prof. T. G. Bonney, F.R.S.—On the Cambrian (Sedgw.) and Silurian rocks of Scandinavia, by J. E. Marr, B.A., F.G.S. The author has examined the following areas of Cambrian and Silurian rocks in Scandinavia:—(1) Dalecarlia, (2) Ostrogothia and Westrogothia, (3) Christiania. (4) Scania, (5) Baltic Isles. A sketch of the stratigraphy of each of these regions was given, and the author gave the following conclusions:—

Silurian.	Mudstones of Ramsåsa and Bjersjölagård	= Ludlow.
	Cardiola beds: *Cyrtograptus* and *Retiolites* Shales	= Wenlock.
	Lobiferus Shales: Upper part of Brachiopod beds	= May Hill
Cambrian.	Lower part of Brachiopod beds	= Upper Bala.
	Trinucleus Shales: *Beyrichii* Limestone ...	= Middle Bala.
	Kärgårde Shales: Cystidean Limestone ...	= Lower Bala.
	&c.	= &c.

A correlation with the beds of Bohemia was also given. The author pointed out that there is evidence of a physical break, varying in amount, as well as of a palæontological one between the Cambrian and Silurian of Scandinavia. Several of the beds of Scandinavia admit of a very exact parallel with strata in the English Lake district. The author considered that the fauna of these Scandinavian deposits affords evidence of migrations. This can be shown by observing that the same forms occur in two beds of different age, but are absent from an intermediate one; or by tracing beds laterally, and showing that the forms occur in an earlier deposit in one locality than in another. The author considered the black shales deep-water deposits, and accounted

for their wide extent by supposing the material derived directly from the decomposition of the felspar in metamorphic rocks, and so in a very fine state of division. The deep-water fauna in the Cambrian appears to have migrated from the south-west; the shallow-water forms, as might be expected, were more variable n their direction of migration: examples were given in support of this view. In Silurian times the direction of migration appears to have changed, the dispersal taking place from Britain, owing probably to greater local upheaval there. The coast-line also, instead of running in a west-north-west and east-south-east direction, seems to have run more west-south-west to east-north-east, as shallow-water forms are common in Britain, but deep-water forms in the central Swedish area. The result of the author's investigations, as bearing on classification, is that there is a break in Scandinavia at the base of the equivalents of the May Hill series, but no other break in the Cambrian series of Sedgwick of equal importance: no break, physical or palæontological, existing at the base of the *Ceratopyge*-limestone (Tremadoc), where some authors have drawn a boundary.

Zoological Society, April 18.—Prof. W. H. Flower, LL.D., F.R.S., president, in the chair.—Prof. Flower read a paper upon the mutual affinities of the animals composing the order Edentata, in which the usual binary division into *Phyllophaga* (or *Tardigrada*) and *Entomophaga* (or *Vermilingua*) was shown not to agree with the most important structural characters. These, according to the interpretation put upon them by the author, indicate that the *Bradypodidæ* and *Megatheriidæ* are allied to the *Myrmecophagidæ*, and also, though less closely, to the *Dasypodidæ*—all the American forms thus constituting one primary division of the order, from which both the *Manidæ* and *Orycteropodidæ* of the Old World are totally distinct.—A communication was read from Mr. Charles Darwin, F.R.S., introducing a paper by Dr. Van Dyck, of Beyrout, on the modification of a race of Syrian street dogs by means of natural selection.—Mr. Oldfield Thomas read an account of a small collection of mammals made by Mr. A. Forrer in the State of Durango, Central Mexico, in which examples of several northern forms, not hitherto recorded so far south, and several southern forms not hitherto known so far north, occurred.—A communication was read from Mr. Edward Bartlett, containing notes on a collection of mammals and birds formed by Mr. J. Hauxwell, in the neighbourhood of Nauta, Elvira, and Loretoyacu, on the Peruvian Amazons. The collection contained examples of new species of *Thamnophilus* and of *Crypturus*, which were proposed to be called *T. loretoyacuensis* and *C. balstoni*.—A communication was read from Mr. Edgar A. Smith, containing an account of the collections of terrestrial and fluviatile Mollusca lately made in Madagascar by Mr. W. Johnson and the Rev. W. Deans Cowan. Various new and interesting species of the genera *Cyclostoma*, *Vitrina*, *Helix*, *Stenogyra*, *Melanatria*, *Cleopatra*, *Ampulliaria*, *Limnæa*, *Physa*, *Planorbis*, *Corbicula*, and *Pisidium* were described.

Meteorological Society, April 19.—Mr. J. K. Laughton, F.R.A.S., president, in the chair.—C. P. Bolton, J. Dale, Capt. G. Gaye, T. T. Marks, G. Neame, A. F. Osler, F.R.S., and Miss E. I. Pogson were balloted for, and duly elected Fellows of the Society.—The papers read were:—Barometric gradients—wind velocity and direction at the Kew Observatory, by G. M. Whipple, B.Sc., F.R.A.S., F.M.S., and T. W. Baker, F.M.S. For the purpose of investigating the subject of the relation of the force and direction of the wind to the distribution of barometric pressure, the authors have discussed the Kew observations for the five years 1875-79. The results show that the rate at which the wind blows increases almost directly with the inclination of the gradient in an arithmetical proportion, the mean rate of increase being 1·85 mile per hour for each additional ·0025 inch of difference in the barometer readings at each end of the slope. The authors find that the angle at which the wind crosses the line of gradient at Kew does not vary with either the steepness of the gradient or the velocity of the wind to any material extent, and also that the angle is found generally to lie between 40° and 60°, the average of the whole series of observations giving a deviation of 52°—On difference of temperature with elevation, by George Dines, F.M.S. In this paper the author gives a summary of his observations made at Walton on-Thames during the last six years. Two stands, almost identical in size and construction, were used, one being placed on the ground, and the other on the top of the tower of the house, the bulbs of the thermometers in the former being four feet, and in the latter fifty feet above the ground. The results show that the average maximum temperature for every month is always greater, and the average minimum lower, on the ground than that on the tower.

Chemical Society, April 20.—Dr. Gilbert, president, in the chair.—The following papers were read:—On the atomic volume of iodine by Dr. Ramsay. The mean value obtained was 36·69.—On molecular volumes, by Dr. Ramsay. The author contrasts the relative probabilities of the antagonistic theories of Kopp and Schröder, and concludes that Schröder's hypothesis is untenable. The author has also determined the molecular volume of the group CH_2 at various pressures, and concludes that its value is less constant the higher the pressure; thus at 20 mm. pressure it varies from 17 to 21, at 30 atmospheres from 26 1 to 54·3.—On the action of acetone on phenanthraquinone, both alone and in the preseece of ammonia, by Dr. F. R. Japp and F. W. Streatfield. A white crystalline substance is formed, $C_{17}H_{15}NO_2$, which melts with decomposition about 230°, and when dissolved in strong hydrochloric acid and diluted with much water, forms a crystalline substance, $C_{17}H_{11}O_3$, melting at 90°. By heating phenanthraquinone and acetone in sealed tubes to 200° this substance $C_{17}H_{14}O_3$ is also formed, and by passing ammonia through its ethereal solution the substance first described $C_{17}H_{15}NO_2$ can be prepared.—A study of some of the earth metals contained in samarskite, by H. E. Roscoe. The author has obtained, by crystallising a mixture of formiates of terbia and yttria, rhombic crystals exactly resembling the so-called formiate of philippium. This supposed new metal, philippium, has therefore no existence.—On the spectrum of terbium, by H. E. Roscoe and A. Schuster.—On the action of thiophosphoryl chloride upon silver nitrate, by T. E. Thorpe and S. Dyson. The authors hoped to obtain a mixed anhydride resembling nitric anhydride in which some of the oxygen was replaced by sulphur, but no such substance was formed.—On the action of potassium amalgam, sulphuretted hydrogen, and potassic hydrate respectively on tetra- and pentathionate of potassium, by V. Lewes. Potassium amalgam and tetrathionite form hyposulphite, but if excess of alkali be present, some sulphide is produced; pentathionates furnish similar products.—On the action of zinc, magnesium, and iron as reducing agents with acidulated solutions of ferric salts, by T. E. Thorpe. The conditions for maximum reduction in the case of zinc are: concentration of the ferric salt, a small amount of free acid, and a rather high temperature. Magnesium acts much less efficiently than zinc. With iron a rise of temperature apparently decreases the reducing action.

Anthropological Institute, April 4.—Major-General Pitt-Rivers, F.R.S., president, in the chair.—The election of Everard F. im Thurn was announced.—The president exhibited a series of carvings and painted masks from New Ireland.—A paper on the Papuans and Polynesians was read by Mr. C. Staniland Wake, who, from a consideration of the physical peculiarities of the Oceanic Races, arrived at the following conclusions:—1. The Eastern Archipelago was at a very early period inhabited by a straight-haired race belonging to the so-called Caucasian stock, the present modern representatives of which are the Australians. 2. To this race belonged also ancestors of all the Oceanic races, including the Papuans, the Melanesians, the Micronesians, the Tasmanians, and the Polynesians, as shown by their common possession of certain physical characters. 3. The special peculiarities of the several dark races are due to the introduction of various foreign elements, the Negritos having influenced all of them in varying degrees. 4. The lighter Oceanic races show traces of the Negrito influence, but they have been affected at various periods by intermixture with peoples from the Asiatic area, giving rise on the one hand to the so-called "savage Malays," and on the other hand to the Polynesians, who have been specially affected by the Malays. 5. Traces of an Arab or Semitic element are apparent among both the dark and the light Oceanic races, but chiefly among the Papuans and Melanesians, the former of whom may also possibly possess a Hindoo admixture. Mr. C. Pfoundes read a paper on "Rites and Customs in Old Japan," and exhibited a number of photographs and Japanese books and pictures.

Entomological Society, April 5.—Mr. H. T. Stainton, F.R.S., president, in the chair.—Exhibitions: A box of *Hymenoptera*, mounted on glass, by Mr. J. R. Billups; a remarkable *Coccinella*, intermediate between *C. oblongoguttata* and

ocellata, by Rev. H. S. Gorham; and a very complete collection of British *Trichoptera*, by Mr. R. McLachlan.—Mr. A. G. Butler communicated a continuation of his Heterocerous *Lepidoptera*, collected in Chili by Mr. T. Edmonds, in which forty-five species of *Noctuæ* were noticed.

Victoria (Philosophical) Institute, April 17.—Dr. Wallich delivered a lecture describing the results of his investigations during the last twenty-two years into the question of the origin of life, his studies having led him to go over the ground that Prof. Haeckel has investigated.

Berlin

Physiological Society, April 17.—M. du Bois-Reymond, president.—Dr. Schiffer lectured about the effects of guachamaka-poison. An extract was made from the wood of the poisonous plant, which, like curare, is soluble in water and alcohol, and gives the general reactions of an alkaloid. The effects of the extract were tried on frogs, pigeons, and rabbits. A latent period of about fifteen minutes was always noticed. This was followed by a loss of vital and motor powers, although the activity of the heart and of the organs of respiration was not impaired. When small doses were given, the animals recovered after a few days; when large doses were given, the impairment of their powers ended in producing death. The muscles could be stimulated directly, but not indirectly, through the medium of the nerves. The guachamaka-poison had, consequently, exactly the same effects as curare. The circumstance that both these poisons must be administered in 25 times as large quantities, when given by the mouth, than when administered hypodermically, gave origin to some attempts to discover the reason of this difference. It was determined that these poisons are neither very rapidly thrown out of the system in the urine, when they have been absorbed, nor are there substances present in the alimentary canal, which decompose them. The probable cause of the difference is, that these poisons are with difficulty absorbed from the stomach.—Dr. v. Ott read a communication about the formation of nutritive albumen in the digestive canal. A frog's heart, which had been rendered pulseless by washing it out with salt solution, and which commences to beat again under action of nutritive (*i.e.* serum) albumen, was used as a reagent, in order to recognise the presence of this albumen. Peptone had no action on the pulseless frog's heart, but the contents of the intestinal tube of a dog, who had been fed on albuminous food-stuffs, had; consequently, serum-albumen must have been formed.—Prof. Adamkiewicz, of Krakau, gave a description of the anatomical alterations in a case of incipient tabes, and a description of the blood-vessels in the spinal cord, which form a very close capillary network. He believes that he can trace back tabes to a disease of the capillary vessels of the spinal cord.

Paris

Academy of Sciences, April 17.—M. Jamin in the chair.—The following papers were read:—On the transformation of oxysulphide of carbon into ordinary and sulphurated ureas, by M. Berthelot.—Conservation of the hand by removal of bones of the carpus and radio-carpian resection, by M. Ollier. He has so operated in fifteen cases, and, after the first four, with very satisfactory results; the patients being able to use the hand in a light way, and several to do hard work with it.—Report on the photographic description of the Alps, by M. Civiale. This great enterprise is warmly eulogised by the Commission. M. Civiale selected forty-one panoramic centres, where he operated both as geodesian and photographer. In some cases he had to climb with his apparatus more than 3000 metres. At each station the apparatus was directed in fourteen equidistant azimuths, and the photographs were joined together. M. Civiale devotes 600 separate plates to details of the Alps, photographed at as many secondary stations. Full descriptions, containing much to interest the engineer and ordinary traveller, are given in his journal.—On quarantines at Suez, by M. Fauvel. He reviews at some length the prophylactic measures taken in recent years. M. de Lesseps seems to have been inadequately informed; what he proposes is exactly (M. Fauvel says) the *ordinary* practice at Suez; facilities as great as possible where the ship from a distance is really healthy; serious measures against every infected ship, or ship suspected of being so.—Method of observation of meteors at the summit of the Puy de Dôme, by M. Alluard. A circular terrace with balustrade has been formed round the tower; the balustrade is divided into 360° (N. 0°, E. 90°, &c.) and the localities all round are referred to this graduation. Two terrestrial telescopes are supported on chariots running on rails round the terrace. Geographical maps are constructed, having concentric circumferences round the Puy de Dôme and radii from it. The origin and course of any meteor (thunderstorm, mist, &c.) is easily and exactly observed.—On spermatogenesis in plagiostones and in amphibians, by M. Sabatier.—The death of M. Giffard was referred to.—Observations of planets 221, 222, 223, and 224, and of comet *a* 1882 (Wells) at Paris Observatory, by M. Bigourdan.—Elements and ephemerides of comet *a* 1882 (Wells) by the same.—Observations at Marseilles Observatory, by M. Coggia.—On the theory of uniform functions of a variable, by M. Mittag-Leffler.—On a property of the circle, by M. Darboux.—On a passage of the "Mecanique analytique," relative to the principle of the least action, by M. Brassinne.—On pernitric acid, by MM. Hautefeuille and Chappuis. On formation of pernitric acid by electrisation of dry air, when the maximum tension for a given temperature has been reached, the electric discharges decompose the acid suddenly into hyponitric acid and oxygen (shown by sudden fall of pressure, and an intense red colour). A retrogration of ozone takes place simultaneously, through heat liberated in decomposition of the acid. In presence of certain proportions of hyponitric acid neither ozone nor pernitric acid can be re-formed. To get as much pernitric acid as possible, one should operate at a low temperature; (other conditions are indicated).—On some reactions of salts of protoxide tin, by M. Ditte.—Action of ammoniac gas on nitrate of ammonia, by M. Raoult.—On the discovery of alkaloids derived from proteic animal matters, by M. Gautier. In 1873 he observed and announced that putrefaction of albuminoid matters gave rise to true fixed and volatile alkalies; (Selmi later).—On tetranitrated bromide of ethylene, by M. Villiers.—On the origin of saccharine matters in the plant, by M. Perrey. Cane-sugar is a product of direct elaboration of the green cells. Glucose, never found in the plant without saccharine, is probably derived from the latter by hydration. A reaction between saccharose and glucose, secondary in the leaf, primary in the seed, produces starch. In germination starch is transformed into dextrine and glucose. In normal nutrition saccharose appears with an essential *rôle*.—On the Echinida of the Senonian strata of Algeria, by M. Cotteau.—On the brain of *Arctocyon Dueilii* and of *Pleuraspiaotherium Aumonieri*, mammalia of the lower eocene of the environs of Rheims, by M. Lemoine.—A "Traité d'Hydrographie," by M. Germain, was presented; also a volume by M. Pochet, entitled "Theory of the motion in curves on railways, with its applications to way and material; new method of ensuring the perfect working of axles in curves." M. Pochet expresses a hope that the State, which is about to construct no less than 14,000 to 15,000 km. of new lines within a few years, may take the initiative in fixing at the outset the elements of the typical railway, and that his theory may be of service for this.

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